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THE EVALUATION OF MOTIVATION AND THE EFFECTIVENESS
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WITHIN REMEDIAL EDUCATION STUDENTS

DISSERTATION
Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of the Ohio State University

By
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The Ohio State University
1971

Approved by

Joseph P. Arnold
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CHAPTER I.
INTRODUCTION

Much has been claimed on behalf of the open-door college. Assertions have been advanced that community junior colleges "salvage human resources"\(^1\), afford individuals "a second chance"\(^2\), and implement the American dream of "universal education for all"\(^3\). In this context some writers have referred to the community college as "democracy's college"\(^4\). Proponents of the open-door concept of admissions have insisted that the community college, with its willingness to offer courses

\(^1\) Sugarman, Michael N., "What About the Dropouts?", *Michigan Education Journal* 44; April, 1967, p. 43.


below the collegiate level, has been the salvation of the remedial student\(^5\).

While it is true that community junior colleges have established courses and curricular programs to accommodate low-achieving students, little research has been produced that demonstrates the success of these programs in remedying student deficiencies. Two-year institutions have tended to implement courses and programs in a trial-and-error fashion hoping that students will succeed, but having little evidence that they will.

By far the majority of students who enroll in remedial courses fail to complete the course satisfactorily and are doomed to failure or forced to terminate their education. A state-wide investigation of students enrolled in remedial English classes in California public junior colleges found that from 40 to 60 percent earned a grade of "D" or "F".\(^6\) The attrition rate in remedial mathematics is similarly high.\(^7\) Other research indicates that as many as 75 percent of remedial students drop out


of college their first year. At present the only tenable value for students enrolled in remedial courses seems to be that it allows the student to say, years after his short tenure, "I went to college." Except for this inestimable benefit, little else is apparent.

1. **Statement of the Problem.**

A total explanation and remedy of the above stated junior college problem is well beyond the scope of the present research which has the purpose of dealing with three specific questions:

1. Are remedial students less motivated than non-remedial students?

2. Can the performance of remedial students be enhanced by modifying instruction in a manner that promotes motivation?

3. Can the effectiveness of a remedial course be enhanced by modifying instruction in a manner that promotes motivation?

As is indicated by the questions, within the scope is a possible partial explanation which may suggest instructional procedures for improving the effectiveness of remedial classes, programs and curricula.
2. **Introductory Definitions and Insights Into the Problem.**

The partial explanation of the stated problem, the remedial student's lack of success, is based on a theory of achievement motivation that is advanced by John W. Atkinson and Norman T. Feather. This theory, referred to as need achievement (n achievement) theory, and related research suggests that people differ in their motivation to be successful ($M_s$) and their motivation to avoid failure ($M_{AF}$). According to the theory these motivations are directly related to one's effort at a task or level of performance. From this relationship the partial explanation is deduced - on the average the motivation to be successful ($M_s$) is lower for remedial students than for non-remedial students. This explanation, an assumption, is frequently asserted in the general statement, "these students lack motivation".

The n achievement theory explains a person's motivation, meaning his amplitude or vigor of action at a task, through the variables of motive, expectancy, and incentive. In the context of n achievement theory, these variables have the following definitions:

---


1. motive - a disposition or tendency to try for a kind of satisfaction or avoid a dissatisfaction. (Note the distinction between "motive" and motivation, one's amplitude or vigor of action.)

2. expectancy - an anticipation that an act of certain behavior will be followed by a particular consequence.

3. incentive - the relative attractiveness of a reward or goal.

The achievement theory of Atkinson can be more succinctly introduced by the following equation:

\[ T = T_s + T_f \]  \hspace{1cm} (I-1)

where

- \( T \) = an active impulse to undertake a particular achievement oriented activity.
- \( T_s = M_s \times P_s \times I_s \)  \hspace{1cm} (I-2)
- \( M_s \) = motive to approach success (in this research a relative magnitude will be accessed by the score on the personality questionnaire as shown in Appendix I.
- \( P_s \) = subjective probability of success, ranging on a scale from 0.00 to 1.00.
\[ I_s = \text{incentive value of success}; \text{it is assumed that } I_s = (1 - P_s). \]

\[ T_{-F} = M_{AF} \times P_F \times (-I_F) \quad (I-3) \]

\[ M_{AF} = \text{motive to avoid failure (in this research a relative magnitude will be assigned by } 10 \text{ minus the score on the personality questionnaire as shown in Appendix I).} \]

\[ P_F = \text{subjective probability of failure}; \]

\[ P_F = 1 - P_s. \]

\[ I_f = \text{incentive value of failure}; = \]

\[ I_f = 1 - P_F. \]

Motives, \( M_s \) and \( M_{AF} \), are conceived of as general and stable characteristics that are learned during childhood experiences\(^{10}\). In regard to this, the incorporated research designs are not concerned with changing motives; they are concerned with the manipulation of classroom environments to promote motive directed behavior. Motive directed behavior occurs when environmental cues indicate that some performance will lead to achievement.

The strength of an expectancy depends on the subjective probability of the anticipated consequence. One's subjective assessment of probability also depends on environmental cues which may suggest high probability

(approaching 1.0). When the consequence has an intermediate subjective probability, the expectancy value may take on the intermediate range from .3 to .7.

The incentive value of a goal or reward is assumed to be related to the difficulty of obtainment. If easily obtained, the expectancy value is high and the incentive value is low; if difficult to obtain, the expectancy value is low and the incentive value is high. Therefore, the incentive value of a goal also ranges from 0.0 to 1.0. This value increases as the value of the goal increases.

Since two motives, the motive to be successful ($M_s$) and the motive to avoid failure ($M_{AF}$), are used to explain one's resultant motivation, two expectancy and two incentive values appear in the formulation of the theory: the expectancy of success ($P_s$), the expectancy of failure ($P_f$), the incentive value of success ($I_s$) and the negative incentive value of failure ($-I_f$). The expectancy or subjective probability of failure ($P_f$) increases as the $P_s$ decreases; therefore, $P_f = 1 - P_s$. This indicates that the incentive value to avoid failure is high when the probability of success is high or when the task is easy.

The consequence of this formulation (previous Eq. I-1) is to be considered as a model and the relationship between the variables and motivation are shown in Table
I (the tables and figures have been placed as close a proximity to their initial reference as possible throughout the dissertation) where a value of 1 was assumed for both $M_S$ and $M_{AF}$. Note that this has the effect of zero resultant motivation. Under experimental conditions one is to expect $M_S > M_{AF}$ or $M_{AF} > M_S$. The values of Table I are plotted in Fig. 1.

The resultant motivation is indicative of the effort one expends at a task and is equal to the sum of motivation to succeed and motivation to avoid failure. Since motivation to avoid failure, the value $(M_{AF} \times P_F \times (-I_F))$, is always negative, there is no effort expended when this value is greater than motivation to succeed, the value $(M_S \times P_S \times I_S)$. When motivation to succeed is the larger, the effort expended depends primarily on the variables $M_S$, $P_S$, and $I_S$. $M_S$ is a constant value and depends on the person confronted with a task. $P_S$ and $I_S$ depend on the environmental cues present with the motivating situation and can range in value from 0.0 to 1.0. When possible values for $P_S$ and $I_S$ are substituted in the formula (for example: .1, .2, .3, etc.), the resultant motivation is maximized when $P_S = 0.5$. This is interpreted to mean that when motivation to succeed is greater than motivation to avoid failure, one's resultant motivation or expended effort at a task can be maximized by adjusting environmental
Table I.-Aroused to achieve (approach) and to avoid (avoidance) as a joint function of motive (M), expectancy (P), and incentive (I), where $I_s = (1 - P_s)$ and $I_F = (-P_s)$.

<table>
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<th>MOTIVATION TO AVOID FAILURE</th>
<th>RESULTANT MOTIVATION</th>
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<td></td>
<td>$M_s \times P_s \times I_s = \text{approach}$</td>
<td>$M_{AF} \times P_F \times I_F = \text{avoidance}$</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>1 .10 .90 .09</td>
<td>1 .90 -.10 -.09</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>1 .20 .80 .16</td>
<td>1 .80 -.20 -.16</td>
<td>0</td>
</tr>
<tr>
<td>C</td>
<td>1 .30 .70 .21</td>
<td>1 .70 -.30 -.21</td>
<td>0</td>
</tr>
<tr>
<td>D</td>
<td>1 .40 .60 .24</td>
<td>1 .60 -.40 -.24</td>
<td>0</td>
</tr>
<tr>
<td>E</td>
<td>1 .50 .50 .25</td>
<td>1 .50 -.50 -.25</td>
<td>0</td>
</tr>
<tr>
<td>F</td>
<td>1 .60 .40 .24</td>
<td>1 .40 -.60 -.24</td>
<td>0</td>
</tr>
<tr>
<td>G</td>
<td>1 .70 .30 .21</td>
<td>1 .30 -.70 -.21</td>
<td>0</td>
</tr>
<tr>
<td>H</td>
<td>1 .80 .20 .16</td>
<td>1 .20 -.80 -.16</td>
<td>0</td>
</tr>
<tr>
<td>I</td>
<td>1 .90 .10 .09</td>
<td>1 .10 -.90 -.09</td>
<td>0</td>
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</table>
Figure 1.- Aroused to achieve (approach) and to avoid (avoidance) as a joint function of motive (M), expectancy (P), and incentive (I); refer to Table I for the numerical values used to plot this curve.
cues so that the subjective probability of success approaches 0.5. As the tasks become more difficult or easier, the resultant motivation decreases. In a similar manner, the motivation to avoid failure is maximized when the subjective probability of success is 0.5. Therefore, when motivation to avoid failure is greater than the motivation to succeed, the greatest reluctance to expend effort at a task occurs when the probability of failure is 0.5. Reluctance is minimized as the task becomes easier or harder since there is little embarrassment when one fails at a difficult task, and there is little possibility of failing at an easy task.

In view of the assumption used for a partial explanation of the remedial student's lack of success, that remedial students lack motivation, achievement theory suggests the following direction: maximize resultant motivation by manipulating the classroom environment to provide cues that promote motive directed behavior and vary expectancy values of success. Specific procedures for manipulating the environment are presented within design II and III.


The research procedure for the three designs deals respectively with the following hypotheses (here the previously stated questions are stated as research hypotheses):
1. Remedial students have a significantly lower motive to succeed than non-remedial students (to be tested in design I).

2. The performance of remedial students can be enhanced by manipulating motive-related cues in the classroom environment (to be tested in design II).

3. The effectiveness of a remedial course can be enhanced by modifying instruction according to achievement theory (to be tested in design III).

Results of design I, a survey, will provide information for judging the validity of the assumption concerning remedial students; the remedial student's lack of success is due, in part, to a lack of motivation. There are two reasons this assumption may not be supported: (1) the assumption is not true, or (2) the questionnaire used to measure motive to succeed is not accurate. That the questionnaire (Appendix I) is probably accurate enough for the present usage can be demonstrated by the manner it was constructed and results of previous usage.\footnote{Costello, C. G., "Two Scales to Measure Achievement Motivation." \textit{The Journal of Psychology} 66: pp. 231-235 1967.} \footnote{Costello, C. G., "Need Achievement and College Performance." \textit{The Journal of Psychology} 69: pp. 17-18, 1968.}
Design II is an experimental procedure. This procedure is intended to increase the quality of student performance by manipulating or providing motivational cues in the classroom. If student performance is not increased, it may be concluded that resultant motivation has not been affected by the procedure. If the quality of performance on course test scores is increased by the procedure, then there is reason to modify instruction on the basis of achievement theory.

The content of design III is a procedure for evaluating the effectiveness of remedial mathematics and physical science courses that have incorporated within them instructional modifications.

Each experimental design will be discussed in detail within following chapters.
CHAPTER II.
RATIONALE FOR THE RESEARCH

Most educators are quick to agree that motivation exists as a major variable affecting classroom performance. It is to be expected therefore, that the open-literature includes to a great extent information and theory relative to this important subject, however, this is far from being the case. Furthermore, the occasional concern of psychologists with motivational theory has been from without the sphere of academic motivation on most occasions. Thus, with the paucity of relevant information on the subject of classroom motivation, the rationale of this research is somewhat forthright.

Experimental findings of a few investigators, however, does provide hope and insight into the subject of classroom motivation. Such results allow the evolvement of some postulates and hypotheses relevant to the teaching-learning process. Paramount among the evidence as was presented in the introduction is the theory of achieve-
Atkinson's theory provides a somewhat deductive approach to a variety of behavioral phenomena and consequently gives some insight into educationally relevant research. Exploration of the theory may well provide an answer to the question, Can Atkinson's theory serve as a step toward a pragmatic theory of academic motivation to assist the classroom teacher and curriculum designer?


As was previously hinted there exists, among the paucity of literature, evidence in support of Atkinson's theory of motivation achievement, the majority of which concerns itself with the "motive to succeed" behavior and not the "motive to avoid failure" behavior. This may be somewhat unfortunate in that is is postulated


within this research that for remedial students in general, $M_{AF} > M_s$, i.e., the magnitude of the index "motive to avoid failure" is greater than the "motive to succeed". However, in that the relationship between the behavior of the two is dipolar, it has not been essential to fully pursue research of both. To indicate the behavior is dipolar is to conclude that what is true of one is the reverse of the other.

Perhaps the major prediction of Atkinson's theory (and in light of the previous statements the most researched) is that the achievement-oriented Ss will be more motivated toward moderately difficult tasks ($P_s = .5$) than failure-threatened Ss. Here achievement-oriented Ss are those for whom $M_s > M_{AF}$ and the opposite for failure-threatened Ss.

The supportive evidence of Atkinson's theory is within the realm of using choice-preference, persistence, or level of performance as an index of motivation. These indexes are to now be discussed with respect to the theory.
Choice-preference. - There exists a number of studies involving competitive, game-like situations\textsuperscript{17,18,19,20,21} where achievement-oriented Ss consistently showed preference of performing tasks that had an intermediate probability of success ($P_s = .5$).

This concept of choice-preference is pictorially shown in Fig. 2 for $M_s > M_{AF}$ and $M_{AF} > X_s$ curves.

Considering this phenomenon (again dipolar in nature when the $M_s > M_{AF}$ curve is compared with the $M_{AF} > M_s$ curve) any modification in instruction to promote an increase in motivation (attractiveness of a task is considered a relative index of motivation) should provide for choice-preference, choice-preference being the Ss preference for a specific region along the abscissa of probability. It might be well to state at this point


\textsuperscript{21}Atkinson, J. W. and Litwin, G. H., Achievement motive and test anxiety conceived as motive to approach success and motive to avoid failure. \textit{Journal of Abnormal and Social Psychology}, 60: pp. 52-63; 1960.
Figure 2.-The concept of choice-preference for \( M_{AF} > M_s \) and \( M_s > M_{AF} \).

Remedial \( \circ \) (lower abscissa)
Non-Remedial \( \bullet \) (upper abscissa)

ATTRACTION OF TASK

Probability of Success, \( P_s \)

Probability of Failure, \( P_f \)
that the treatments of design III result from just this consideration.

This differential tendency of choice-preference (or three regioned tendency, see again Fig. 2) was noted within studies\textsuperscript{22,23,24,25} concerned with aspiration level on intellectual tasks. That is, within Fig. 2 there is a choice-preference for region I and III by the Ss for whom $M_{AF} > M_s$. Region II is preferred by the $M_s > M_{AF}$ Ss. Thus assuming choice-preference as an index of motivation, Atkinson's theory is supported.

\textbf{Persistence.} Atkinson's theory specifies the functional property of a motive as a relatively general disposition that will influence actions to lead to an increase (or decrease) in persistence for a particular con-

\begin{itemize}
\item \textsuperscript{23} Moulton, R. W., Effects of success and failure on level of aspiration as related to achievement motives. \textit{Journal of Personality and Social Psychology}, \textit{1}: pp. 399-406; 1965.
\item \textsuperscript{24} Isaacson, R. L., Relation between achievement, test anxiety, and curricular choices. \textit{Journal of Abnormal and Social Psychology}, \text{25}: pp. 283-293; 1957.
\end{itemize}
sequence or goal. Several authors$^{26,27,28,29}$ have provided evidence to support the validity of the persistence theory.

As will be discussed later, persistence will be manipulated with treatment 2 (mixed-modal examination) within design III. Treatment 2 will have as its basis the belief that one's persistence to succeed can be manipulated and enhanced by keeping a student on the brink of "almost succeeding" or i.e., by manipulating the success-failure pattern so that it is cyclic.

**Performance.**—Performance has a multiplicity of dependent variables associated with it. Consequently, one must very succinctly provide for its definition within an experimental design. Performance as will be measured in this research shall be that index associated with examination grades...the higher the examination grade the greater the performance.

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The investigator is of the belief that performance as defined above can be manipulated within the context of cueing. Cueing would thus constitute a situational effect. Measures of "attractiveness of success" within a situational domain through cueing have been determined by several authors.\textsuperscript{30,31,32,33} The pictorial description of the consequence of cueing on performance is depicted in Fig. 3.

Consequently, cueing is expected to increase performance over all levels of probability of success (and also all levels of probability of failure).

2. Rationale From Atkinson's Theory Pertinent to Design Constructs of this Research.

The rationale of this research rests with three general implications of Atkinson's Theory which are as follows:

1. Persons in whom $M_{AF} > M_s$, who therefore have a negative resultant achievement motivation, will avoid intermediate risk when constrained to undertake an achievement-


\textsuperscript{31}Litwin, G. H., unpublished honors thesis, Department of Psychology, University of Michigan, 1958.


Figure 3. The pictorial description of the consequence of cueing on performance for the $M_s > M_{AF}$ Ss.
oriented activity by some extrinsic tendency (mixed-modal assignments...to be discussed and manipulated within design III).

2. Changes in motivation are brought about by cyclic patterns of success and failure (mixed-modal examinations...to be discussed and manipulated within design III).

3. An increase in the attractiveness of success can be brought about due to situational factors (cueing...to be discussed within and manipulated in design III).

The above mentioned concept of negative resultant achievement motivation is seen more explicitly in Fig. 4. Within this figure the magnitude of $T_F$ exceeds $T_s$ for all $P_s$ and $P_F$ values, the algebraic sum (the solid curve representing the resultant achievement motivation, $T$) is negative throughout the range of the abscissa.
Figure 4. A pictorial representation of a negative resultant achievement motivation (T) where T is the algebraic sum of T_s and T_F.
CHAPTER III.
DESIGN I: A SURVEY TO MEASURE AN INDEX OF MOTIVATION

The purpose of this survey is to obtain data for testing the hypothesis: Remedial students have a significantly lower motive to succeed than non-remedial students. Within design I three separate disciplines are tested with respect to the above hypothesis. For each discipline a sequence of three steps was administered as follows: (a) the selection of two groups, a remedial and a non-remedial group; the groups are denoted as group A and group B, respectively; (b) the administering and scoring of the Personality Questionnaire (Appendix I) which served as a measure of the motive to succeed; and (c) a statistical treatment of the scores to determine if there was a significant difference between the groups A and B for each discipline.

1. Discussion of the Instrument to Measure an Index of Motivation: The Personality Questionnaire.

The personality questionnaire shown within Appendix I is the result of trying to develop a less time-

consuming method of obtaining motivation scores...most tests prior to 1967 embodied a large variety of questions measuring a variety of personality traits.

The ten scales (questions) resulted from an extensive study of an initial listing of 100 items administered to 191 women and 191 men in groups from 10 to 115 Ss. The ages ranging from age 17 to 59 years. A variety of occupations were represented - college students, nurses, psychiatrists, firemen, and theological students. These scales measure the motivation disposition of an individual who wants to do a job well.

2. **Indications of Experimental Validity of the Instrument.**

The personality questionnaire was administered to 198 freshmen college students. Four groups of 10 Ss were rank ordered on the basis of their respective scores. Group 1 consisted of those Ss scoring highest (highest scores are those falling above the upper quartile point). Groups 2, 3 and 4 were within the 2nd, 3rd and 4th quartile ranges, respectively. The mean examination mark for

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36 Ibid.
all the final examinations at the end of the first year was obtained for each student.

The overall mean examination marks for the four groups were Group I, 70.07; Group II, 66.98; Group III, 56.46; Group IV, 53.84.

The rank order of these means was in line with the predictions, and an analysis of variance indicated that the main effect of these scales was significant \( F = 10.196, p < .01 \).

This result suggests the need to achieve through one's own efforts is positively related to performance of college examinations. Consequently, the personality questionnaire was used in design I of this research to test the hypothesis: Remedial students have a significantly lower motive to succeed than non-remedial students.

3. The Methods of Design I.

The remedial and non-remedial Ss were randomly selected from the student population of Chattanooga State Technical Institute (for the continuance of this research the reader is to conclude that all experiments were conducted on Ss of Chattanooga State Technical Institute and thus the investigator will not repeat this with each selection of Ss). Selected were three sets of groups A and B, one set each for mathematics, physical
science, and English. There was no duplication of students across the respective disciplines.

**Mathematics.**—The remedial group A of 24 Ss was randomly selected from a population of 81 students enrolled in remedial mathematics courses designated as Mathematics 10.

The non-remedial group B of 24 Ss was randomly selected from a population of 42 students enrolled in non-remedial mathematics courses designated as Mathematics 115, 125, and 135, respectively. The restriction placed on this population was that they had not previously been enrolled within a remedial course.

**Physical Science.**—The remedial group A of 24 Ss was randomly selected from a population of 79 students enrolled in remedial physical science courses designated as Physics 10.

The non-remedial group B of 24 Ss was randomly selected from a population of 54 students enrolled in non-remedial physical science courses designated as Physics 114, 124, and 134, respectively. The restriction placed on this population was that they had not previously been enrolled within a remedial course.

**English.**—The remedial group A of 24 Ss was randomly selected from a population of 152 students enrolled in remedial English courses designated as English 10.

The non-remedial group B of 24 Ss was randomly selected from a population of 87 students enrolled in the non-remedial English course designated as English 113.
The restriction placed on this population was that they had not previously been enrolled within a remedial course.

The selection of Ss for design I is summarized in Table II.

The instrument, Appendix I, was administered to the total population of each discipline within a thirty-six hour period. It was the desire of the investigator to keep this time length at a minimum to prevent familiarization and discussion of the instrument among the population (note the total population was tested).

The decision to test the total population was to reduce the Hawthorne effect among Ss. Each instructor was provided a list of the names of the randomly selected Ss among his students. He or she was asked to familiarize himself with the names to the extent of being able to separate the Ss from the population when collecting the completed instruments. Consequently, the S's test instruments were provided the investigator without any apparent problem.

Prior to administering the test instrument (Appendix I) to measure motive to succeed the following instructions were passed out to the students and read aloud:

1. The questions on the following page have been designed to show where you should be placed in certain personality traits. There are no

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Table II.- A summary of the Ss selected for the three disciplines of mathematics, physical science and English within experimental design I.

<table>
<thead>
<tr>
<th></th>
<th>GROUP A</th>
<th>GROUP B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MATHEMATICS</strong></td>
<td>24 remedial mathematics students</td>
<td>24 non-remedial mathematics students</td>
</tr>
<tr>
<td><strong>PHYSICAL SCIENCE</strong></td>
<td>24 remedial physical science students</td>
<td>24 non-remedial physical science students</td>
</tr>
<tr>
<td><strong>ENGLISH</strong></td>
<td>24 remedial English students</td>
<td>24 non-remedial English students</td>
</tr>
</tbody>
</table>
"right" or "wrong" answers to these questions. It is, therefore, impossible to get a "good" or "bad" score. Each question is to be answered yes or no. All questions must be answered by choosing only one of the two alternative answers.

2. Please do not place your name on the instruction or question sheet.

3. It is very important that you answer honestly and without any lengthy deliberation on any questions.

4. The class results as a whole will be used to decide upon the modes of instruction for this and other similar classes, e.g., lecture versus individualized study, outside speakers versus no outside speakers, etc.

The results of findings from the administration of the instrument, as described above, are presented within Chapter VI.
CHAPTER IV.

DESIGN II: AN EXPERIMENT FOR MANIPULATING

ACHIEVEMENT MOTIVE-RELATED CUES IN THE CLASSROOM

Design II is an experimental research procedure for testing the following hypothesis: The performance of remedial students can be enhanced by manipulating achievement motive-related cues in the classroom environment. Generally, achievement motive-related cues suggest a standard of excellence and are found with the following situations and conditions. 37,38

1. A competitive situation.
2. A situation in which performance is compared with criteria of acceptability.
3. The presence of a task which is or should be of importance.
4. The presence of an authority figure.
5. The presence of achievement related words (e.g., "success" and "strive").

Promoting any of the above situations is a means of promoting achievement motive-directed behavior. Simi-

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38 Ibid.
lar to previous research, this experiment provides moti-
vational cues through the instructions given prior to
a test. The experiment consisted of five steps: (1) The
selection of students, (2) The selection of a test,
(3) The administration of the test, (4) The statistical
treatment of the scores, and (5) The conclusions and
discussion of the results.

1. Methods of Design II.

Two groups of remedial students were randomly
selected for the experiment of Design II. One group
consisted of 24 Ss of remedial mathematics students
selected from a population of 117 students. These
students were enrolled within the Mathematics 10
courses. The other group consisted of 24 Ss of stu-
dents selected from a population of 46 students enrolled
in Physical Science 10 courses.

A test instrument consisting of alternate parts
A and B for each of the two disciplined groups was ad-
ministered on two consecutive days.

Selection of a Test Instrument: Alternate Parts
A and B. - The mathematics test used met the following
criteria:

1. The test consisted of alternate parts A and B,
of equal difficulty.

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McClelland, D. C., Atkinson, J. W., Clark, R. A. and
Lowell, E. L. The Achievement Motive. New York:
Appleton-Century-Crofts, 1953.
2. The test was short enough to allow completion within one class period.

3. The test was appropriately difficult for the remedial student.

In regard to the last criterion, the test was selected according to the grade level at which the remedial students perform. For example, by examining the college entrance examinations it was estimated by the investigator that the students performed at a tenth (plus) grade level in mathematics, and consequently, a mathematics test for ninth, tenth and eleventh grades was designed.

The following steps were carried out to obtain equivalent alternate forms, A and B, for both the remedial mathematics and remedial physical science tests:

1. The investigator selected four problems each for twenty categories in remedial mathematics and fourteen categories in remedial physical science, respectively.

2. These categories and parts were presented to referees (7 mathematics and 5 science referees) who in turn selected what in their opinion constituted two equivalent problems for each category, thus reducing the two tests to "equivalent" forms, A and B.

3. The equivalent forms A and B were administered to a randomized grouping of non-remedial students in mathematics and physical science to check for equivalency.
The referees as mentioned above were selected from the mathematics and science faculty at the Chattanooga State Technical Institute.

The investigator selected problems for mathematics and physical science are shown in Appendix II and III, respectively. These were administered to the referees with the following instructions attached to the selected problems:

1. The attached represents twenty (fourteen for the physical science) questions of four parts each. The investigator wishes to compose two tests of parts A and B of equal difficulty.

2. Parts a through d for each question are in the investigator's view of equal difficulty, however, other opinions are needed to attest to the equality.

3. You are asked to aid in reducing each question to two parts by placing in the boxes to the left the two parts, e.g., a and d, that in your opinion are of equal difficulty.

4. The test will then be separated into two parts by viewing the frequency distributions of a, b, c, and d for each question.

Tally distributions for both groups of referees and disciplines are shown in Appendix IV. The magnitude of the tally represents the total number of times the particular question was chosen as one of a pair.
The underlined tallies within Appendix IV constitute the particular pair for each specific question and represent the parts receiving the greater number of selections by the referees. In some questions two or more tallies were of equal magnitude. For such cases the investigator gave preference to the tally first occurring from left to right.

Appendix V, VI, VII and VIII show the resultant examinations (parts A and B) for mathematics and physical science, respectively.

Validation of Parts A and B of the Test Instrument.—A group consisting of 24 non-remedial mathematics students enrolled in Mathematics 135 was selected to validate whether the parts A and B, Appendix V and VI respectively, were equivalent in difficulty as selected by the referees. The 24 Ss were then randomly separated into two groups of 12 each for the purpose of administering the parts A and B of the test.

A group consisting of 24 non-remedial physical science students enrolled in Physical Science 114 was selected to validate whether parts A and B, Appendix VII and VIII, respectively, were equivalent in difficulty as selected by the referees. The 24 Ss were then randomly separated into two groups of 12 each for the purpose of administering parts A and B of the test.
Validation for both disciplines was made with respect to the following hypothesis:

**Null hypothesis:** Part A is equivalent to Part B. This hypothesis was tested with the previously described groups and found to be significant at the .01 level for both the mathematics and physical science tests with t values of .024 and .049, respectively.

The results of findings with respect to the validations as described above are presented within Chapter VI.

*Administering of the Test Instrument: Design II.*

Administering the test (parts A and B) is the key part of the experimental procedure of design II. The test was administered twice, once with instructions and statements designed to produce achievement motive-directed behavior (the motivating condition) and once without such instructions and statements (the non-motivating condition). Also, this procedure for administering the test eliminates other factors that could account for students performing better during the motivating condition. For the motivating condition, the first administration of the test, the procedure consisted of two basic steps:

1. Part A was distributed to the class.
2. Before the students started the test, they were informed of the following: This test was especially chosen to provide an index of your ability in mathematics (or physical science).
The test will also indicate how you compare, in terms of mathematics (or physical science) ability, with students like yourself in other schools. So that I have a true picture of what your mathematics (or physical science) talents are, it is important that you do as well as possible.

The second administration of the test, part B, was given on the following day to prevent the students from having learning experiences that would raise their scores. Also, prior to the second administration of the test, the students did not receive any information on how they performed on the first testing.

Such information would have influenced their expectancy of success or failure and therefore, affect their motivation for the second testing. There were two steps for the second administration of the test:

1. The test forms were distributed (part B).
2. Before the students started the test, they were informed of the following: This test is similar to the one you took yesterday. The principal reason I am giving the test is to see how useful it might be for this course. The score you get will not influence your grade.
The test instrument (Appendix V and VI for mathematics and Appendix VII and VIII for physical science) was administered to the remedial groups as previously described within the section on group selection for design II. Results of the findings are shown in Chapter VI.
CHAPTER V.

DESIGN III: AN EVALUATION OF INSTRUCTIONAL MODIFICATIONS BASED ON \( n \) ACHIEVEMENT THEORY

Design III is an experimental procedure for evaluating the effectiveness of remedial mathematics and remedial physical science courses that incorporate instructional modifications based on \( n \) achievement theory. The question is whether or not students learn more (performance enhanced) in a class with such modifications. Consequently, the hypothesis to be tested can be stated as follows: The class performance of an experimental group incorporating \( n \) achievement theory will exceed the class performance of a control group not incorporating \( n \) achievement theory. The criterion for assessing performance was departmental examinations given to all students at the end of a 10 day (10 classes) time frame.

1. Additional Insights of Atkinson's Theory Pertinent to Design III.

A recent experiment\(^4\) has helped to clarify one problem concerning the relationship between measures of

the strength of a particular motive (Achievement) and performance. Performance is positively related to the strength of a particular motive only when an expectancy of satisfying that motive through performance has been aroused, and when expectancies of satisfying other motives through the same action have not been sufficiently aroused to confound the simple relationship. This is to say that when expectancies of attaining several different kinds of incentives are equally salient in a situation, the determination of motivation to perform an act is very complex. Performance is then overdetermined in the sense that its strength is now a function of the several different kinds of motivation which have been aroused. The ideal situation for showing the relationship between the strength of a particular motive and behavior is one in which the only reason for acting is to satisfy that motive.

The discussions which follow pertain to such an ideal achievement-related situation, which is at best only approximated in actual experimentation or in the normal course of everyday life. Consequently, the investigator will concern himself with only two motives, the motive to achieve success and the motive to avoid failure.

Behavior directed toward achievement and away from failure. The problem of selection is confronted in the level-of-aspiration situation where the individual must choose among tasks which differ in degree of difficulty.
The problem of accounting for the vigor of performance arises in the situation which will be referred to as constrained performance. Here, there is no opportunity for the individual to choose his own task. He is simply given a task to perform. He must, of course, decide to perform the task rather than to leave the situation. There is a problem of selection. In referring to this situation as constrained performance, it is the investigator's intention to deal only with those instances of behavior in which motivation for the alternative of leaving the situation is less positive or more negative than for performance of the task that is presented. Hence, the individual does perform the task and the question of interest is the specific level of performance.

Elaboration of the implications of the multiplicative combination of motive, expectancy, and incentive, as proposed to account for strength of motivation, will be instructive if we can find some reasonable basis for assigning numbers to the different variables. The strength of expectancy can be represented as a subjective probability ranging from 0. to 1.00. But the problem of defining the positive incentive value of a particular accomplishment and the negative incentive value of a particular failure is less tangible.
In past discussions of level of aspiration, Escalona\textsuperscript{41} and Festinger\textsuperscript{42} have assumed that, within limits, the attractiveness of success is a positive function of the difficulty of the task, and that the unattractiveness of failure is a negative function of difficulty, when the type of activity is held constant. The investigator will go a few steps farther with these ideas, and assume that degree of difficulty can be inferred from the subjective probability of success $P_s$. The task an individual finds difficult is one for which his subjective probability of success $P_s$ is very low. Now we are in a position to make simple assumptions about the incentive value of success or failure at a particular task. Let us assume that the incentive value of success $I_s$ is a positive linear function of difficulty. If so the value $1 - P_s$ can represent $I_s$, the incentive value of success. When $P_s$ is low (e.g., .10) a difficult task, $I_s$ is high (e.g., .90). The negative incentive value of failure $I_f$ can be taken as $-P_s$. When $P_s$ is high (e.g., .90), as in confronting a very easy task, the sense of humiliation accompanying failure is also very great (e.g., -.90). However, when $P_s$ is low (e.g., .10),


as in confronting a very difficult task, there is little embarrassment in failing (e.g., -.10). We assume, in other words, that the (negative) incentive value of failure $I_F$ is a negative linear function of difficulty.

It is of some importance to recognize the dependence of incentive values intrinsic to achievement and failure upon the subjective probability of success. One cannot anticipate the thrill of a great accomplishment if, as a matter of fact, one faces what seems a very easy task. Nor does an individual experience only a minor sense of pride after some extraordinary feat against what seemed to him overwhelming odds. The implications of the scheme which follows rest heavily upon the assumption of such a dependence.

In previous Table I values of 1 were arbitrarily assigned to the achievement motive $M_S$ and the motive to avoid failure $M_{AF}$. This table contains the strength of motivation to approach success ($M_S \times P_S \times I_S$) and motivation to avoid failure ($M_{AF} \times P_F \times I_F$) through performance of nine different tasks labeled A through I. The tasks differ in degree of difficulty as inferred from the subjective probability of success ($P_S$). The incentive values of success and failure at each of the tasks have been calculated directly from the assumptions that incentive value of success equals $1 - P_S$ and that incentive value of failure equals $-P_S$; and $P_S$ and $P_F$ are assumed to add to 1.00.
Table I may be considered an extension of ideas presented by Escalona and Festinger concerning levels of aspiration. The present formulation goes beyond their earlier proposals (a) in making specific assumptions regarding the incentive values of success and failure, and (b) in stating explicitly how individual differences in strength of achievement motive and motive to avoid failure influence motivation.

When the achievement motive is stronger \( M_s > M_{AF} \). The right-hand column of Table I shows the resultant motivation for each of the tasks in this special case where achievement motive and motive to avoid failure are equal in strength. In every case there is an approach-avoidance conflict with resultant motivation equal to 0. This means that if the achievement motive were stronger than the motive to avoid failure - for example, if we assigned \( M_s \) a value of 2 - the resultant motivation would become positive for each of the tasks and its magnitude would be the same as in the column labeled Approach. Let us therefore consider only the strength of approach motivation for each of the tasks, to see the implications of the achievement theory for the


person in whom the need for achievement is stronger than
his disposition to avoid failure.

One thing is immediately apparent. Motivation to
achieve is strongest when uncertainty regarding the out­
come is greatest, i.e., when $P_s$ is .50. If the indivi­
dual were confronted with all of these tasks and were
free to set his own goal, he should choose Task E where
$P_s$ is .50, for this is the point of maximum approach
motivation. The strength of motivation to approach de­
creases as $P_s$ increases from .50 to near certainty of
success ($P_s = .90$), and it also decreases as $P_s$ decreases
from .50 to near certainty of failure ($P_s = .10$).

If this person were to be confronted with a single
task in what is here called the constrained performance
situation, we should expect him to manifest strongest
motivation where $P_s$ equals .50. If presented either
more difficult tasks or easier tasks, the strength of
motivation manifested in performance should be lower.
The relationship between strength of motivation as ex­
pressed in performance level and expectancy of success
at the task in other words, should be described by a
bell-shaped curve.

When the motive to avoid failure is stronger
($M_{AF} > M_s$), let us now ignore the strength of approach
motivation and tentatively assign it a value of 0., in
order to examine the implications of n achievement
theory for any case in which the motive to avoid failure
is the stronger motive. The resultant motivation for each task would then correspond to the values listed in the column labeled Avoidance.

What should we expect of the person in whom the disposition to avoid failure is stronger than the motive to achieve? It is apparent at once that the resultant motivation for every task would be negative for him. This person should want to avoid all of the tasks. Competitive achievement situations are unattractive to him. If, however, he is constrained (e.g., by social pressures) and asked to set his level of aspiration, he should avoid tasks of intermediate difficulty \( (P_s = .50) \) where the arousal of anxiety about failure is greatest. He should choose either the easiest \( (P_s = .90) \) or the most difficult task \( (P_s = .10) \). The strength of avoidant motivation is weakest at these two points.

In summary, the person in whom the achievement motive is stronger should set his level of aspiration in the intermediate zone where there is moderate risk. To the extent that he has any motive to avoid failure, this means that he will voluntarily choose activities that maximize his own anxiety about failure. On the other hand, the person in whom the motive to avoid failure is stronger should select either the easiest of the alternatives or should be extremely speculative and
set his goal where there is virtually no chance for success. These are activities which minimize his anxiety about failure.

2. **Experimental Treatments of Design III as a Consequence of Atkinson's Theory.**

It is important for the investigator to choose experimental treatments that result from close examination of Atkinson's achievement theory. This was the case for this research and the treatments are as follows:

Treatment 1. Cueing

Treatment 2. Mixed-Modal Assignments

Treatment 3. Mixed-Modal Examinations

The basic assumption underlying these treatments (as per the results of design I) is that the magnitude of the resultant behavior for remedial students is due to the motivation to avoid failure, i.e., \( M_{AF} > M_s \). These treatments shall now be defined and succinctly discussed.

**Treatment 1: Cueing.** Cueing is the act of reinforcement that results in increased motivation. As was previously stated cueing is expected to increase the magnitude of \( I_s \) and decrease \( I_F \). Consequently, resulting is a change of the attractiveness of the task as depicted in Fig. 5.

Cueing acts which are expected to bring about reinforcement were previously discussed and are noted again as follows:
Figure 5. - The effect of cueing on attractiveness of task, before and after reinforcement

Before cueing, upward shift of both curves.

AFTER CUEING,
UPWARD SHIFT OF BOTH CURVES.
1. A competitive situation.
2. A situation in which performance is compared with criteria of acceptability.
3. The presence of a task which is or should be of importance.
4. The presence of an authority figure.
5. The presence of achievement related words (e.g., "success" and "strive").

The above acts were combined as a treatment within design III.

**Treatment 2. Mixed-Modal Assignments.** The mixed-modal assignment can be described as providing the Ss with the choice of executing an easy (E), medium (M) or difficult (D) problem assignment. Basic theory was presented in previous sections of this chapter relative to the remedial student's need to perform within one of two regions with respect to the abscissa of $P_s$ or $P_F$ (refer again to Fig. 2).

Relative to Fig. 2 the $M_{AF} \succ M_s$ Ss have a bi-modal preference (EASY or DIFFICULT) and consequently, the naming of mixed-modal assignment for treatment 2.

Treatment 2 was administered to one of the selected groups of Ss for design III. The procedure for the treatment was for the investigator to provide three problems for each singular problem assignment. These problems were placed on separate sheets of paper and labeled EASY, MEDIUM, or DIFFICULT. The student chose one of the
three possible assignments each day. It was indicated to the Ss that each problem had a maximum value of ten points and consequently, a value of ten could be made on a problem labelled EASY as well as one labelled HARD.

**Treatment 3. Mixed-Modal Examinations.**-Treatment 3, mixed-modal examinations, has to do with varying the difficulty of the daily administered examination (five minutes) from day to day thus resulting in varying degrees of success (or failure). This consequence shall now be examined in more detail.

1. The effects of success and failure.-Let us consider achievement theory and ask, "What are the effects of success and failure on the level of motivation?" We may refer back to Table I to answer this question. First, let us consider the effects of success or failure on the level of motivation in a person whose motive to achieve is stronger than his motive to avoid failure ($M_A > M_F$). In the usual level-of-aspiration situation, he should initially set his goal where $P_S$ equals .50. In Table I, this is Task E. If he succeeds at the task, $P_S$ should increase. And, assuming that the effects of success and failure generalize to similar tasks, the $P_S$ at Task D, which was initially .40, should increase toward .50. On the next trial, $P_S$ at Task E is now greater than .50, and $P_S$ at Task D now approaches .50. The result of this change in $P_S$ is diminished motivation
to achieve at the old task, E, and increased motivation to achieve at Task D, an obviously more difficult task. The observed level of aspiration should increase in a step-like manner following success, because there has been a change in motivation.

A further implication of the change in strength of motivation produced by the experience of success is of great consequence: given a single, very difficult task (e.g., $P_s = .10$), the effect of continued success in repeated trials is first a gradual increase in motivation as $P_s$ increases to .50, followed by a gradual decrease in motivation as $P_s$ increases further to the point of certainty ($P_s = 1.00$). Ultimately, as $P_s$ approaches 1.00, satiation or loss of interest should occur. The task no longer arouses any motivation at all. Why? Because the subjective probability of success is so high that the incentive value is virtually zero. Here is the clue to understanding how the achievement motive can remain insatiable while satiation can occur for a particular line of activity. The strength of motive can remain unchanged, but interest in a particular task can diminish completely. Hence, when free to choose, the person who is stronger in achievement motive should always look for new and more difficult tasks as he masters old problems. If constrained, the person with a strong achievement motive should experience a gradual loss of interest in his work. If the task is
of intermediate difficulty to start \((P_s = .50)\), or is definitely easy \((P_s > .50)\), his interest should begin to wane after the initial experience of success.

But what of the effect of failure on the person who is more highly motivated to achieve than to avoid failure? Once more we look at the Approach column of Table I. If he has chosen Task E \((P_s = .50)\) to start with and fails at it, the \(P_s\) is reduced. Continued failure will mean that soon Task F (formerly \(P_s = .60\)) will have a \(P_s\) near .50. He should shift his interest to this task, which was objectively less difficult in the initial ordering of tasks. This constitutes what has been called a lowering of the level of aspiration. He has moved to the easier task as a consequence of failure.

What is the effect of continued failure at a single task? If the initial task is one that appeared relatively easy to the subject (e.g., \(P_s = .80\)) and he fails, his motivation should increase. The \(P_s\) will drop toward .70, but the incentive value or attractiveness of the task will increase. Another failure should increase his motivation even more. This will continue until \(P_s\) has dropped to .50. Further failure should then lead to a gradual weakening of motivation as \(P_s\) decreases further. In other words, the tendency of persons who are relatively strong in achievement motive to persist at a task in the face of failure is
probably attributable to the relatively high subjective probability of success, initially... Hence, failure has the effect of increasing the strength of their motivation, at least for a time. Ultimately, however, interest in the task will diminish if there is continued failure. If the initial task is perceived by the person as very difficult to start with (\( P_S < 0.50 \)), motivation should begin to diminish with the first failure.

Let us turn to the effect of success and failure on the motivation of the person who is more strongly disposed to be fearful of failure (\( M_{AF} > M_S \)). If the person in whom the motive to avoid failure is stronger has chosen a very difficult task in setting his level of aspiration (e.g., Task A \( P_S = 0.10 \)) and succeeds, \( P_S \) increases and his motivation to avoid the task is paradoxically increased. It would almost make sense for him deliberately to fail, in order to keep from being faced with a stronger threat on the second trial. If there are more difficult alternatives, he should raise his level of aspiration to avoid anxiety. Fortunately for this person, his strategy (determined by the nature of his motivation) in choosing a very difficult task to start with protects him from this possibility, because \( P_S \) is so small that he will seldom face the paradoxical problem just described. If he fails at the most difficult task, as is likely, \( P_S \) decreases
further, \( P_f \) increases further, and the aroused motivation to avoid failure is reduced. By continued failure he further reduces the amount of anxiety about failure that is aroused by this most difficult task. Hence, he should continue to set his level at this point. If he plays the game long enough and fails continuously, the probability of failure increases for all levels of difficulty. Sooner or later the minimal motivation to avoid failure at the most difficult task may be indistinguishable from the motivation to avoid failure at the next most difficult task. This may ultimately allow him to change his level of aspiration to a somewhat less difficult task without acting in gross contradiction to the proposed principle of motivation.

If our fearful subject has initially chosen the easiest task (Task I where \( P_s = .90 \)) and if he fails, \( P_s \) decreases toward .80, and his motivation to avoid the task also increases. If there is no easier task, the most difficult task should now appear least unattractive to him, and he should jump from the easiest to the most difficult task. In other words, continued failure at a very easy task decreases \( P_s \) toward .50; and, as Table I shows, a change of this sort is accompanied by increased arousal of avoidant motivation. A wild and apparently irrational jump in level of aspiration from very easy to very difficult tasks, as a con-
sequence of failure, might be mistakenly interpreted as a possible effort on the part of the subject to gain social approval by seeming to set high goals. The present achievement theory predicts this kind of activity without appealing to some extrinsic motive. It is part of the strategy of minimizing expected pain of failure after one has failed at the easiest task.

If our fear-disposed subject is successful at the most simple task, his \( P_s \) increases, his \( P_f \) decreases, and his motivation to avoid this task decreases. The task becomes less and less unpleasant. He should continue playing the game with less anxiety.

Table I when taken in its entirety, deals with the special case of the person in whom the two motives are exactly equal in strength. The implications are clear. In the constrained-performance situation, he should work hardest when the probability of success is .50, because motivation to achieve and motivation to avoid failure will summate in the constrained instrumental act which is at the same time the pathway toward success and away from failure. (This summation should also occur in the cases where one motive is stronger.) But in the level-of-aspiration setting where there is an opportunity for choice among alternatives, the avoidance motivation exactly cancels out the approach motivation. Hence, the resultant motivation for each of the alternatives is zero. His choice of level of aspiration cannot be predicted from variables intrinsic to the achievement-re-
lated nature of the task. If there is any orderly pattern in this conflicted person's level of aspiration, the explanation of it must be sought in extrinsic factors, e.g., the desire to gain social approval. Such a desire can also be conceptualized in terms of motive, expectancy, and incentive, and the total motivation for a particular task can then be attributed to both achievement-related motives and other kinds of motives engaged by the particular features of the situation.

Treatment 3, mixed-modal examinations, was administered daily to one of the remedial mathematics groups of design III. The investigator from day to day made the test more difficult (failure) or easier (success). Difficult or easier is defined here as whether the class average was below 50% or above 50%, respectively.

3. Methods of Design III.

Six groups of Ss were randomly selected for the experiments of design III. The 72 Ss of three of the six groups were selected from the remedial mathematics population of 121 students. The 72 Ss of the other three groups were selected from a population of 72 remedial physical science students. Table III summarizes the groups and the respective treatments randomly assigned to each group for execution within design III.

Control of Extraneous Variables for Design III: A Programmed Technique.-To control very explicitly for
Table III.- The groups of design III and their respective treatments.

<table>
<thead>
<tr>
<th>GROUP(i)</th>
<th>DISCIPLINE</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>A(1)</td>
<td>Remedial Mathematics</td>
<td>Control</td>
</tr>
<tr>
<td>B(2)</td>
<td>Remedial Mathematics</td>
<td>Mixed-modal Exams.</td>
</tr>
<tr>
<td>C(3)</td>
<td>Remedial Mathematics</td>
<td>Cueing</td>
</tr>
<tr>
<td>A(4)</td>
<td>Remedial Phys. Sci.</td>
<td>Control</td>
</tr>
</tbody>
</table>
extraneous variables that conceivably would affect the results of the treatments of design III, line flow charts were constructed. The flow charts are presented in Appendix IX and X for the remedial mathematics groups and the remedial physical science groups, respectively. Variation in instruction is felt to have been controlled to the extent that one instructor administered all three remedial mathematics groups and one instructor administered all three remedial physical science groups.

The results of findings for design III from the administration of the instruments (departmental examinations) shown in Appendix XI and Appendix XII are presented within Chapter VI.
CHAPTER VI.

RESULTS OF FINDINGS FOR DESIGN I, II AND III.

The results of findings concern themselves explicitly with three specific questions stated within the introductory chapter and restated as follows:

1. Are remedial students less motivated than non-remedial students?
2. Can the performance of remedial students be enhanced by modifying instruction in a manner that promotes motivation?
3. Can the effectiveness of a remedial course be enhanced by modifying instruction in a manner that promotes motivation?

Investigational results paralleling these three questions are to now be presented in light of the methods of design I, II and III.

1. Results of Design I: Are Remedial Students Less Motivated Than Non-remedial Students?

Null and research hypotheses were stated as pre-experimental conditions as follows:

(a) Null Hypothesis: Remedial and non-remedial students have an equal motive to succeed.
(b) Research Hypothesis: Remedial students have a lower motive to succeed than do non-remedial students.

The type of sampling distribution is the t distribution with one tail and the condition of rejection set at a .05 level of significance (t > -1.68).

Experimental data collected as a result of administration of the personality questionnaire (Appendix I) for measuring motive are shown in Appendixes XIII, XIV and XV for the disciplines of mathematics, physical science, and English, respectively.

Table IV is in summary of the results of design I. As shown within the table, the null hypothesis was rejected for the disciplines of mathematics and English and accepted for physical science.

2. Results of Design II: Can the Performance of Remedial Students be Enhanced by Modifying Instruction in a Manner that Promotes Motivation?

Null and research hypotheses are stated as pre-experimental conditions as follows:

(a) Null Hypothesis: The class performance of an experimental group incorporating cueing theory will equal that of an experimental group not incorporating cueing.

(b) Research Hypothesis: The class performance of an experimental group incorporating cueing theory will exceed that of an experimental group not incorporating cueing.
Table IV.- Summary of the results of design I for the disciplines of mathematics, physical science and English.

HYPOTHESES

$H_0 : A=B$: Remedial and non-remedial students have an equal motive to succeed.

$H_1 : A<B$: Remedial students have a lower motive to succeed than do non-remedial students.

<table>
<thead>
<tr>
<th>Discipline</th>
<th>$H_0$</th>
<th>$H_1$</th>
<th>$t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATHEMATICS</td>
<td>Rejected</td>
<td>Accepted</td>
<td>-1.79</td>
</tr>
<tr>
<td>PHYSICAL SCIENCE</td>
<td>Accepted</td>
<td></td>
<td>-1.51</td>
</tr>
<tr>
<td>ENGLISH</td>
<td>Rejected</td>
<td>Accepted</td>
<td>-2.19</td>
</tr>
</tbody>
</table>
The type of sampling distribution is the \( t \) distribution with one tail and the condition of rejection set at a .05 level of significance.

The experimental data collected as a result of administration of the test instruments for mathematics (Appendixes V and VI) and physical science (Appendixes VII and VIII) are shown in Appendix XVI.

Table V is in summary of the results of design II. As shown within the table, the null hypothesis was rejected for the discipline of mathematics and accepted for physical science.

The investigator feels that there may exist a logical explanation for the failure to reject the null hypothesis for physical science. Cueing should be considered in light of its effect over a short period of duration (e.g., five minutes before an exam) versus its effect over a longer period of time (e.g., the time interval which shall be used in design III, 2 weeks). The opinion is expressed that cueing for a short period (such as design II) will be more effective in mathematics than in physical science as was the case. The reason for this opinion being that elementary mathematics requires more concentration than recall of techniques as in the case with physical science. In other words the effect of short duration cueing is increased
Table V.- Summary of the results of findings of design II.

<table>
<thead>
<tr>
<th>Remedial Mathematics</th>
<th>$H_0$: Rejected</th>
<th>$H_1$: Accepted</th>
<th>$t = 1.73$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remedial Physical Science</td>
<td>$H_0$: Accepted</td>
<td>$t = 1.23$</td>
<td></td>
</tr>
</tbody>
</table>
alertness to the problem at hand and alertness is more beneficial to the solving of elementary mathematics problems than physical science problems that demand more procedural techniques to solve.

Cueing over a longer duration of time has an effect of increased study which quite obviously should increase the performance of the student. Longer-duration-cueing shall be tested in design III for both mathematics and physical science.

3. Results of Design III: Can the Effectiveness of a Remedial Course be Enhanced by Modifying Instruction in a Manner That Promotes Motivation?

Null and research hypotheses are stated as pre-experimental conditions as follows:

(a) Null Hypothesis: The class performance of an experimental group incorporating n achievement theory will equal the class performance of a control group not incorporating n achievement theory.

(b) Research Hypothesis: The class performance of an experimental group incorporating n achievement theory will exceed the performance of a control group not incorporating n achievement theory.

These hypotheses were tested using the one-way analysis of variance technique at a .05 level of significance.
Experimental data collected as a result of administration of the test instruments for mathematics (Appendix XI) and physical science (Appendix XII) are shown in Appendixes XVII and XVIII, respectively.

Table VI is in summary of the one-way analysis of variance results of design III for the mathematics and physical science groups.

As shown in Table VI the F values were of such magnitudes to reject the null hypotheses for both disciplines at a .05 level of significance. However, this result alone is not very satisfactory. What we would like to know is how the means differ. Is every mean significantly different from every other? Are there some differences between some of the means and not between others? The Duncan Multiple Range Test was used to answer these questions.

Results of using the Duncan Multiple Range Test to determine whether there was a significant difference between three or more means tested by the analysis of variance are shown in Table VII(a) and VII(b) for mathematics and physical science, respectively.

By examining the results of the Duncan-Multiple Range test for mathematics (Table VII(a)) it can be seen that the difference between mean A (control) and mean B (mixed-modal examinations) is significant at a
Table VI.— One-way analysis of variance results of design III for mathematics and physical science, respectively.

### MATHEMATICS

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>BETWEEN</td>
<td>2827</td>
<td>2</td>
<td>1413.5</td>
<td>3.64*</td>
</tr>
<tr>
<td>WITHIN</td>
<td>23830</td>
<td>66</td>
<td>361</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>26657</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### PHYSICAL SCIENCE

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>BETWEEN</td>
<td>1586</td>
<td>2</td>
<td>793</td>
<td>3.33*</td>
</tr>
<tr>
<td>WITHIN</td>
<td>14998</td>
<td>63</td>
<td>238.1</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>16584</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* .05 level of significance
Table VII(a).-Results of Duncan-multiple range test for design III; remedial mathematics.

<table>
<thead>
<tr>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>SIG. RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A(CONTROL)</td>
<td>B(MIXED-MODAL EXAMINATIONS)</td>
<td>C(CUEING)</td>
<td>SHORTEST</td>
<td></td>
</tr>
<tr>
<td>MEANS</td>
<td>57.00</td>
<td>68.34</td>
<td>72.00</td>
<td></td>
</tr>
<tr>
<td>DIFFERENCES</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A 57.00</td>
<td>11.34</td>
<td>15.00</td>
<td>11.20</td>
<td>.05 level</td>
</tr>
<tr>
<td>B 68.52</td>
<td>3.48</td>
<td>11.80</td>
<td>15.52</td>
<td>.01 level</td>
</tr>
</tbody>
</table>

Table VII(b).- Results of Duncan-multiple range test for design III; remedial physical science.

<table>
<thead>
<tr>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>SIG. RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A(CONTROL)</td>
<td>B(MIXED-MODAL ASSIGNMENTS)</td>
<td>C(CUEING)</td>
<td>SHORTEST</td>
<td></td>
</tr>
<tr>
<td>MEANS</td>
<td>61.60</td>
<td>68.18</td>
<td>73.60</td>
<td></td>
</tr>
<tr>
<td>DIFFERENCES</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A 61.60</td>
<td>6.58</td>
<td>12.00</td>
<td>8.43</td>
<td>.05 level</td>
</tr>
<tr>
<td>B 68.18</td>
<td>5.42</td>
<td>8.88</td>
<td>11.20</td>
<td>.01 level</td>
</tr>
</tbody>
</table>
.05 level of significance (11.34 exceeds 11.20).
Mean A (control) and mean C (cueing) are significantly different at the .05 level in that 15.00 exceeds 11.20 (the .05 level was the pre-experimental level, however, it should be noted that mean A and mean C are significantly different at the .01 level, shortest significant range value equals 14.88 at a .01 level of significance). There is no significant difference in the two treatments, mixed-modal examination and cueing.

For physical science the Duncan-multiple range values shown in Table VII(b) should be examined. Examination indicates the difference between mean A (control) and mean B (mixed-modal assignments) is not significant at the .05 level (6.58 does not exceed 8.43). Mean A and mean C (cueing) are significantly different at the .05 level (12.00 exceeds 8.43). There is no significant difference between the two treatments, mixed-modal assignments and cueing.
CHAPTER VII
CONCLUSIONS

The preceding chapters have presented experimental methods and results related to the theory of motivation in light of Atkinson's theory. In this chapter the investigator wishes to summarize the main ideas of the research and its contributions.

One of the main values of any effort to test the implications of a theory is increased understanding of the essential ideas and implications of the theory itself. Hopefully, the reiteration of Atkinson's theory has provided for a first introduction, or if already familiar, a reinforcement of the fundamental points. The common understanding of the implications of any theory is essential for the "self-corrective" process of science.

The theory of achievement motivation is but one of a class of theories which attribute the strength of motivation to undertake some activity to the belief that the activity will result in a certain consequence and the attractiveness (or value) of the consequence to the individual. The theory refers, specifically, to a very important but limited domain of behavior, namely, achievement-oriented activity. Achievement-oriented
activity is undertaken by an individual with the expectation that his performance will be evaluated in terms of some standard of excellence. It is presumed that any situation which presents a challenge to achieve, by arousing an expectancy that action will lead to success, must also pose the threat of failure by arousing an expectancy that action may lead to failure. Thus, achievement-oriented activity is always influenced by the algebraic resultant of a conflict between two opposed motivations, the motivation to achieve success and the motivation to avoid failure. Normally, one might pre-suppose, achievement-oriented activities are also influenced by other "extrinsic" motivational tendencies. However, for this research, it was assumed that extrinsic motivational tendencies were controlled within the experimental design or were non-existent.

The investigator offers the following general conclusions as a consequence of having conducted this research:

1. The partial explanation of the stated problem, the remedial student's lack of success, is based on and contained within the realm of achievement motivation theory.
2. People differ in their motivation to be successful ($M_s$) and their motivation to avoid failure ($M_{AF}$).

3. The achievement theory explains a person's motivation, meaning his amplitude or vigor of action at a task, through the variables of motive, expectancy and incentive.

4. The incentive value of a goal or reward is related to the difficulty of obtainment.

Also, statistical inferences can be made with respect to the hypotheses stated and tested within this research. The remainder of this chapter shall concern itself with these inferences.

**Design I.** - The results of design I were significant and conclusive at the .05 level with one noted exception (this being physical science). It is to the extent of this experimental certainty discussed within that the investigator concludes (and as was anticipated) that remedial students have a lesser tendency (motivation) to achieve than non-remedial students. Furthermore, with this being the case, and due to the dipolar nature of the theory with respect to the tendency to succeed ($M_s$) and the tendency to avoid failure ($M_{AF}$), it can be
concluded that for remedial students, $M_{AF} > M_s$. Consequently, the classroom teacher or curriculum designer should be guided by those behavioral-learning characteristics associated with the $M_{AF} > M_s$ student.

**Design II.** The results of design II provide evidence at the .05 level of significance to substantiate that the performance of remedial education students can be enhanced by manipulating achievement motive-related cues in the classroom environment for the mathematics Ss. The failure of the remedial physical science Ss to qualify for success at a .05 level of significance may very well be due to the fact that the entrance test administered at Chattanooga State Technical Institute to determine remedial status is nondiscriminating to the extent of separating the remedial and non-remedial students. The inference can be drawn as a consequence of design II that the tendency to achieve is enhanced by cueing through the increase in magnitude of $I_s$ which in turn increases the motive to achieve ($M_s$) and also cueing decreases $I_F$. The algebraic sum is thus greater than the pre-cueing state. Consequently, classroom teacher behavior should include cueing to facilitate the general disposition that will enhance actions expected to lead to a particular kind of consequence or goal.
Also, it is concluded that the effects of cueing may be time dependent to some extent, i.e., to be effective cueing must take place over an extended period of time. This was discussed in some detail within design II.

**Design III.**—Conclusions for design III are keyed to the three treatments:

1. Cueing.
2. Mixed-modal assignments.

The previous statements for cueing are still adequate and no further comments need be made. The treatment of the mixed-modal assignments (assignment given in multiples) that allows for choice of easy, medium, and hard tasks, i.e., variables \( P_s, P_f \) resulted from the following concept of Atkinson's theory:

The motivation to avoid failure for the remedial student should be strongest when a task (assignment) is of intermediate difficulty.

Consequently, it can be concluded from the above concept that mixed-modal assignments should provide for maximum tendency (motivation) when students can choose \( P_f, P_s \) in the range of say .1 to .35 and .55 to .9.

However, the results of design III for the mixed-modal assignments are not significant (at the .05 level) to the extent of concluding that the classroom teacher's behavior should provide for such a problem assignment procedure.
Mixed-modal examination techniques are within Atkinson's motivation theory concept and are a direct consequence of the following:

For $M_s > M_{AF}$, success strengthens the expectancy of success, and failure weakens the expectancy of success, coupled with the assumption that incentive value of success is dependent upon strength of expectancy of success ($I_s = 1 - P_s$).

Furthermore, Atkinson's risk-taking model predicts that individuals high in fear of failure (remedial students, $M_{AF} > M_s$) and low in need for achievement react in an atypical manner to success and failure experiences, i.e., they may raise their level of aspiration following failure and lower it after success. The results are conclusive within a $0.05$ level of significance that such a technique as mixed-modal examinations increases the proportion of low as contrasted to high levels of aspiration in remedial students.

The investigator concludes that all results with respect to the three designs offer suggested solutions for the classroom teacher of remedial students.
CHAPTER VIII

IMPLICATIONS FOR FURTHER STUDY

It is the opinion of the investigator that the research conducted and reported herein was of adequate significance to warrant further study along the pursuits of Atkinson's motivational theory. Some implications for further research stated as problems are as follows:

1. There exists a need to improve the techniques and accuracy for the measurement and assessment of motive, both $M_s$ and $M_{AF}$.

2. A study of and an improvement of the methods of varying expectation of success needs to be undertaken.

3. There is a need for further analysis of interrelationship between measures of motive, expectation, and incentive values.

4. Study should be undertaken to establish the correlation between student ability and achievement motivation.
5. The implications of Atkinson's theory in relation to programmed instruction should be assessed.

The above stated problems shall now be succinctly outlined.

There exists a need to improve the techniques and accuracy for measurement and assessment of motive, both $M_g$ and $M_{AP}$. There has been no advance in techniques for assessing individual differences in $\mathbf{n}$ achievement since 1949. This discouraging record is not for want of effort. For reasons still not completely understood, objective tests that seem as though they should work as measures of $M_g$ (or $M_{AP}$) do not work. The failure of any test to yield anything even approaching consistent evidence of construct validity as a measure of $\mathbf{n}$ achievement is all the more bewildering in light of the obvious utility of self-report tests of anxiety. Certainly an objective test would have the advantage of ease of administration and scoring.

In summary, the theory suggests that the $\mathbf{n}$ achievement scores probably measure the difference in motives $(M_g - M_{AP})$ whereas the need exists to measure $M_g$ and $M_{AP}$ individually.

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A study of and an improvement of the methods of varying expectation of success needs to be undertaken.

The research reported herein and the literature reviewed reported a number of different procedures for varying strength of subjective probability of success. Some of these involve structuring the actual task situation so that different levels of difficulty are quite apparent to the subject. Thus, varying the time required to complete a task, the number of positive marbles in a "lottery box" and the apparent complexity and/or length of a task are all examples of experimental procedures presenting subjects with a task involving different levels of difficulty that are easily discernible in terms of available cues. These basic procedures are all basically concerned with varying the perceived difficulty of the task in terms of the degree to which the subject expects that he can succeed; and they appear to be relatively successful in meeting this aim. It would, however, be of interest to study the relative effectiveness of these methods and to investigate the possibility that these different procedures may have other types of effects apart from influencing subjects' expectations of success.

There is a need for further analysis of interrelationships between measures of motives, expectation and incentive values.-There exists a definite need for fur-
ther analysis of interrelationships between measures of motives, expectations, and incentive values. The results within this research support the implication that judgement of probability of success is related to measures of the strength of achievement-related motives. A question of vital importance is: To what extent do these results imply complex interactions between the basic terms of the theory such that it becomes difficult to apply? If these studies necessarily imply both that subjective probabilities can influence incentive values and that incentive values can somehow act back to influence subjective probabilities, it would seem the theory is entangled in a complex circuit.

Study should be undertaken to establish the correlation between student ability and achievement motivation. Whether or not ability grouping enhances school performance or produces a decrement in performance should depend upon the relative strength of the motive to achieve success (n achievement) and motive to avoid failure (test anxiety) within the individual student. For many students homogeneous ability grouping should provide a competitive achievement situation more nearly approximating one of intermediate probability of success, or intermediate difficulty, than the traditional heterogeneous class. One such study might well be to group students by a motivational index. This of course is
similar to the practice of ability grouping. Ability grouping being based on the predication that intelligence is the predominant variable affecting performance in schools. Grouping by motivational levels, however, might be more significant. The grouping by motivational levels requires that one accept the concept that achievement motivation is not necessarily correlated with ability. This concept is supported somewhat by research within the literature.\textsuperscript{46,47}

The research methods for this problem should allow for the manipulation and intercomparison of ability and motivation.

The implications of Atkinson's Theory in relation to programmed instruction should be assessed. An instructional innovation that was to have revolutionized the learning process of the low-motivated student is programmed instruction. The fact that it hasn't is obvious to any classroom teacher who has provided such instruction in lieu of more conventional techniques. Prior to this experimentation the investigator felt in general, that the downfall of programmed instruction rested primarily


in the design phase of development, i.e., linear programming that fails to provide for freedom of the student to choose alternatives. This may well be part of its failure, but conceding that programmed instruction is here to stay, (i.e., many materials and texts have been compiled) one might ask, "How can we best make use of programmed materials? The answer may well be apparent (and significant as was shown in this research) within Atkinson's achievement theory...the mixed-modal examinations. Having conducted and examined the results of the mixed-modal examination technique the investigator now expresses the opinion that programmed instruction fails in part (with remedial students, especially) because of the pattern built into the design of the materials...success, success, success. The proposition being put forth is that the examinations within programmed instruction should be put on an individual basis with respect to difficulty, i.e., not all of equal difficulty, but matched to the ability of each student by an instructor. The results would be achievement, reinforcement and motivation through the pattern of success, failure, success, failure, etc...mixed-modal examinations. A suggested research design might well be to select two groups of remedial students for programmed instruction, one being a control group and the other experiencing only the variation of the mixed-modal
examination treatment. The results of the comparisons being derived from a common examination given to both groups to measure the extent of learning. Results of such an experiment might directly repudiate the notion that all Ss will be equally motivated by the same success ratios. Furthermore, such results might change oversimplified assumptions of programmers concerning motivation.
Appendix I.- Personality Questionnaire used within design I to measure the motive to succeed (Or motive to avoid failure).

Course Title _______
Course Number _______

STUDENT INSTRUCTIONS

1. The questions on the following page have been designed to show where you should be placed on certain personality traits. There are no "right" or "wrong" answers to these questions. It is therefore, impossible to get a "good" or "bad" score. Each question is to be answered yes or no. All the questions must be answered by choosing only one of the two alternative answers.

2. Please do not place your name on the instruction or question sheet.

3. It is very important that you answer honestly and without any lengthy deliberation on any question.

4. The class results as a whole will be used to decide upon the modes of instruction for this and other similar classes, e.g., lecture versus individualized study, outside speakers versus no outside speakers, etc.
Appendix I.-Continued

PERSONALITY QUESTIONNAIRE

<table>
<thead>
<tr>
<th>Item number</th>
<th>and</th>
<th>content</th>
<th>circle</th>
<th>answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td>Are you inclined to read of the successes of others rather than do the work of making yourself a success?</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td>Would you describe yourself as an ambitious person?</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td>Do you work for success rather than daydream about it?</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td>Would you describe yourself as being lazy?</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td>Do you usually work to do more than just get through an examination?</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td>Will days often go by without your having done a thing?</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>7.</td>
<td></td>
<td>Do you do things &quot;today&quot; rather than putting them off to do &quot;tomorrow&quot;?</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>8.</td>
<td></td>
<td>Are you inclined to take life as it comes without much planning?</td>
<td>yes</td>
<td>no</td>
</tr>
</tbody>
</table>
Appendix I.-Continued

9. Do you work hard at a job? ............... yes no

10. Do you, or did you, do little preparation for examinations? ............... yes no
Appendix II.— Experimenter selected problems for twenty categories within mathematics for referee manipulation; design II.

INSTRUCTIONS TO REFEREES

1. The attached represents twenty questions of four parts each. The investigator wishes to compose two tests of parts A and B of equal difficulty.

2. Parts a through d for each question are in the investigators view of equal difficulty, however, other opinions are needed to attest to the equality.

3. You are asked to aid in reducing each question to two parts by placing in the boxes to the left the two parts, e.g., a and d, that in your opinion are of equal difficulty.

4. The test then will be separated into two parts by viewing the frequency distribution of a, b, c, and d for each question.
MATHEMATICS EXAMINATION

1. Write the following in decimal form using common fractions.
   (a) five and two hundredths
   (b) one hundred twenty-three and six thousandths
   (c) seventy-one and twenty-one ten-thousandths
   (d) sixty-five thousandths

2. Write the following numbers using powers of ten.
   (a) 28.39
   (b) 109.45
   (c) 6.345
   (d) .00876

3. Change each of the following common fractions to its decimal equal.
   (a) 3/8
   (b) 16/25
   (c) 11/15
   (d) 2/5

4. Find the sums:
   (a) 137.64 + 6.1 + 7.14 + .008 =
   (b) 63. 4.7 + 19.45 + 120.0015 =
   (c) 147.49 + 7.31 + .004 + 8.4 =
   (d) 47 + 6.3 + 20.71 + 170.027 =
Appendix II.-Continued

5. Subtract:
   (a) 72.4 from 159
   (b) 3.12 from 4.7
   (c) 49.41 from 64.718
   (d) 16.412 from 140

6. Perform the following operations:
   (a) 18.4 - 13.72 + 4
   (b) -4.14 - 8.7 - 16.5
   (c) .37 - 4.5 + .008
   (d) 51.7 - 1.11 + 4.6 - 84.1

7. Find the products:
   (a) 3.7 (b) 14.1 (c) 25.03
   (d) 4.162

8. Divide as indicated:
   (a) 36 ÷ 12 (b) 5.1 ÷ 1.9
   (c) .6 ÷ .04 (d) 14.356 ÷ .74

9. Write the following numbers in decimal form:
   (a) 2.68 x 10^0
   (b) 7.68 x 10^2
   (c) 1.36 x 10^{-4}
   (d) 1.45 x 10^3
10. In each of the following problems, find the larger number:

(a) .0037; .0048
(b) .029; .0083
(c) .000042; .00091
(d) .0005; .00049

11. Find the following products using the rule of scientific notation:

(a) \((10^{-5})(10^3)\)
(b) \((10^{11})(10^{-4})\)
(c) \((10^7)(10^6)\)
(d) 66,000 \times .003

12. Find the quotients for the following using the rule of scientific notation:

(a) \(10^3 \div 10^2\)
(b) \(10^6 \div 10^{-2}\)
(c) \(10^{-4} \div 10^{-4}\)
(d) \(10^{-3} \div 10^5\)

13. Round the following numbers to the nearest tenth:

(a) 3.7654
(b) 3.1416
(c) .16666
(d) .05731
14. Change the following from decimal to percent form or from percent to decimal form:

(a) 55%
(b) .75
(c) 100%
(d) .2

15. Solve each of the following:

(a) 48 is 10% of what number?
(b) 60 is 1% of what number?
(c) 5/8 is 5% of what number?
(d) 600 is 200% of what number?

16. Solve each of the following:

(a) Find 50% of 4,000.
(b) What percent of 12 is 6?
(c) 9 is 25% of what number?
(d) Find 18% of 38.

17. Solve each of the following:

(a) 18 is what percent of 30?
(b) 14 is what percent of 50?
(c) 69 is what percent of 50?
(d) 69 is what percent of 52?
Appendix II.—Continued

18. Do as indicated using scientific notation and the rule of exponents.
   (a) $3,500 \times 70$
   (b) $820,000 \div .0008$
   (c) $.0008 \times .000007$
   (d) $.00045 \div 9,000$

19. Convert the decimal fractions to equivalent lowest common fractions.
   (a) .7
   (b) .6
   (c) .11
   (d) .75

20. Write the numbers which follow in scientific notation.
   (a) 236
   (b) 798
   (c) 862.4
   (d) .00613
Appendix III.—Experimenter selected problems for fourteen categories within physical science for referee manipulation; design II.

INSTRUCTIONS TO REFEREES

1. The attached represents fourteen questions of four parts each. The investigator wishes to compose two tests of parts A and B of equal difficulty.

2. Part a through d for each question are in the investigators view of equal difficulty, however, other opinions are needed to attest to the equality.

3. You are asked to aid in reducing each question to two parts by placing in the boxes to the left the two parts, e.g., a and d, that in your opinion are of equal difficulty.

4. The test then will be separated into two parts by viewing the frequency distribution of a,b,c, and d for each question.
PHYSICAL SCIENCE EXAMINATION

1. Express in scientific notation:
   (a) 8,400,000
   (b) 45,000
   (c) 0.0589
   (d) 16

2. Solve:
   (a) 1,000,000 \times 0.00001 \times 0.00001 \times 10,000
   (b) 36 \times 10^3 \times 27 \times 10^{-5} \times 2,200
   (c) 0.000048/5,000
   (d) 214,000 \times 0.00025

3. Add the following and express the answer in scientific notation:
   (a) 100,000 + 1,000,000
   (b) 4 \times 10^2 + 3 \times 10^1 - 0.2 + 4 \times 10^3
   (c) 42,000 - 4,200 + 42,000
   (d) 4.8 \times 10^{-6} + 4.8 \times 10^{-5} - 7 \times 10^{-6}

4. Solve:
   (a) \left( \frac{8 \times 10^{-3}}{4 \times 10^5} \right)^2
   (b) \left( \frac{50 \times 10^{-5}}{25 \times 10^{-6}} \right)^2
   (c) \sqrt{.0025}
   (d) \sqrt{16,000,000}
5. Solve for the unknown:
   (a) $7x + 4 = x - 8$
   (b) $5 - 2x = x - 20$
   (c) $3(y+1) = 12 + 4(y-1)$
   (d) $11x + 3 - 4x = 16 - 2x + 2$

6. Solve for the unknown:
   (a) $\frac{7r - 1}{9} = 1 + \frac{3r + 4}{8}$
   (b) $\frac{2}{x} + \frac{3}{x} = 10$
   (c) $\frac{4}{w} + 3 = 4 - \frac{3}{w}$
   (d) $\frac{8}{v + 4} = \frac{6}{v - 4}$

7. Solve the following formulas for the quantity indicated in parenthesis:
   (a) $F = ma$ Solve for $(m)$
   (b) $2as = V_f^2 - V_o^2$ Solve for $(s)$
   (c) $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ Solve for $(T_2)$
   (d) $a = \frac{V_f - V_o}{t}$ Solve for $(V_o)$
8. Solve the following formulas for the quantity indicated in parenthesis:

(a) \[ s = \frac{rn - a}{r - 1} \] Solve for \( r \)

(b) \[ \frac{1}{p} + \frac{1}{q} = \frac{1}{f} \] Solve for \( f \)

(c) \[ \frac{1}{f} = (n-1)(\frac{1}{r_1} + \frac{1}{r_2}) \] Solve for \( n \)

(d) \[ I = \frac{E}{r + R/n} \] Solve for \( n \)

9. Solve the following system of equations for \( x \) and \( y \).

(a) \[ 2x - 3y = 7 \] \[ 3x + y = 5 \]

(b) \[ 3x - y = -6 \] \[ 2x + 3y = 7 \]

(c) \[ 2x - 5y = 10 \] \[ 4x + 3y = 7 \]

(d) \[ 2x - 3y = 9t \] \[ 4x - 7 = 8t \]

10. Solve the following quadratic equations by factoring:

(a) \[ x^2 - 4x + 4 = 0 \]

(b) \[ x^2 + x - 12 = 0 \]

(c) \[ x^2 = 38 = 8x \]

(d) \[ x^2 = 3x - 2 \]

11. Solve the following equations by completing the square:

(a) \[ x^2 - 2x - 3 = 0 \]

(b) \[ x^2 - 8x - 20 = 0 \]
Appendix III.-Continued

(c) \(2y^2 - y - 2 = 0\)
(d) \(3x^2 - 6x - 8 = 0\)

12. Solve the following equations by using the quadratic formula:

(a) \(x^2 - 5x = 6\)
(b) \(x^2 - 17x + 60 = 0\)
(c) \(x^2 - 6 = x\)
(d) \(3x^2 + 7x = 6\)

13. Solve the proportions for \(x\):

(a) \(\frac{x}{8} = \frac{9}{16}\)
(b) \(\frac{12}{x} = \frac{20}{9}\)
(c) \(\frac{21}{10} = \frac{x}{25}\)
(d) \(\frac{3}{4} = \frac{x}{14-x}\)

14. Solve the following right triangles:

(a) \(A = 30^\circ; c = 20\)  
(b) \(B = 45^\circ; a = 16\)
(c) \(a = 48; b = 24\)  
(d) \(c = 16; A = 18^\circ\)

where

\[\text{Diagram of a right triangle with labels A, B, c, b, a.}\]
Appendix IV.—Frequency distribution of referee’s tally for mathematics and physical science questions of appendix II and III of design II (The two underlined tallies constitute the particular pair for the specific question).

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>MATHEMATICS REFEREE’S TALLY</th>
<th>PHYSICAL SCIENCE REFEREE’S TALLY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a’s b’s c’s d’s</td>
<td>a’s b’s c’s d’s</td>
</tr>
<tr>
<td>1</td>
<td>3 5 3 2</td>
<td>2 5 1 2</td>
</tr>
<tr>
<td>2</td>
<td>2 3 6 3</td>
<td>3 5 1 2</td>
</tr>
<tr>
<td>3</td>
<td>3 5 3 3</td>
<td>2 5 1 4</td>
</tr>
<tr>
<td>4</td>
<td>2 4 4 3</td>
<td>3 5 2 4</td>
</tr>
<tr>
<td>5</td>
<td>4 5 4 1</td>
<td>4 5 2 1</td>
</tr>
<tr>
<td>6</td>
<td>3 5 3 4</td>
<td>3 5 2 1</td>
</tr>
<tr>
<td>7</td>
<td>3 5 3 3</td>
<td>2 5 2 1</td>
</tr>
<tr>
<td>8</td>
<td>1 3 6 4</td>
<td>1 3 3 2</td>
</tr>
<tr>
<td>9</td>
<td>4 3 5 2</td>
<td>4 4 1 1</td>
</tr>
<tr>
<td>10</td>
<td>4 2 5 3</td>
<td>4 3 1 1</td>
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<td>11</td>
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<td>17</td>
<td>3 1 6 4</td>
<td>2 3 2 1</td>
</tr>
<tr>
<td>18</td>
<td>5 2 3 3</td>
<td>2 3 2 1</td>
</tr>
<tr>
<td>19</td>
<td>6 2 2 1</td>
<td>2 3 2 1</td>
</tr>
<tr>
<td>20</td>
<td>5 3 4 2</td>
<td>2 3 2 1</td>
</tr>
</tbody>
</table>
Appendix V.-Remedial mathematics examination: Part a, design II.

INSTRUCTIONS

1. There are twenty questions to be answered.

2. After each question are four possible answers. You are to circle the letter preceding your selection of the correct answer.

For example:

Subtract \(72.4\) from \(159\)

(a) 87.6
(b) 8.66
(c) 86.60
(d) 186.6

(Here (c) is the correct answer.)
Appendix V.—continued

MATHEMATICS EXAMINATION

1. Write (five and two hundredths) in decimal form using common fractions:
   (a) .502
   (b) 5.02
   (c) .520
   (d) .0520

2. Write (109.45) using powers of ten.
   (a) .10945 \times 10^2
   (b) 1.0945 \times 10^2
   (c) 1.0945 \times 10^0
   (d) 10945

3. Change the common fraction \( \frac{3}{8} \) to its decimal equal.
   (a) .375
   (b) .375
   (c) 3.75
   (d) 37.5

4. Find the sum:
   \[
   \begin{array}{c}
   63. \\
   4.7 \\
   19.45 \\
   \hline
   120.0015
   \end{array}
   \]
   (a) 206.1515
   (b) 107.1515
5. Subtract: (72.4 from 159)
   (a) 89.6
   (b) 86.6
   (c) 86.9
   (d) 866

6. Perform the operation (18.4 - 13.72 + 4)
   (a) 7.68
   (b) 8.68
   (c) 6.68
   (d) 66.8

7. Find the product \( 3.7 \times 0.15 \)
   (a) 3.85
   (b) 0.385
   (c) 5.55
   (d) 0.555

8. Divide: \( 0.6 \div 0.04 \)
   (a) 15
   (b) 1.5
   (c) 15
   (d) 30
9. Write \((2.68 \times 10^0)\) in decimal form:
   (a) \(0.268\)
   (b) \(2.68\)
   (c) \(26.8\)
   (d) \(268\)

10. Which of the two numbers \((.0037; .0048)\) is larger?
   (a) \(.0037\)
   (b) \(.0048\)
   (c) \(---\)
   (d) \(---\)

11. Find the product of \((10^{-5})(10^3)\) using scientific notation.
   (a) \(10^{-5}\)
   (b) \(10^2\)
   (c) \(10^{-2}\)
   (d) \(10^0\)

12. Find the quotient of \((10^3 ÷ 10^2)\) using scientific notation.
   (a) \(1.0 \times 10^1\)
   (b) \(1 \times 10^0\)
   (c) \(1 \times 10^2\)
   (d) \(0.1 \times 10^1\)
13. Round the number (3.1416) off to the nearest tenth.
   (a) 3.0
   (b) 3.1
   (c) 3.2
   (d) 3.23

14. Change (55%) to decimal form:
   (a) .0055
   (b) .055
   (c) 55
   (d) .55

15. Solve: 48 is 10% of what number?
   (a) 480
   (b) 48
   (c) 4.8
   (d) .48

16. Solve: Find 50% of 4,000.
   (a) 3,000
   (b) 1,000
   (c) 2,000
   (d) 2,500
17. Solve: 69 is what percent of 50?
   (a) 105%
   (b) 13.8%
   (c) 138%
   (d) 1.38%

18. Find the product of (3,500 x 70) and express the answer in scientific notation:
   (a) 2.45 x 10^5
   (b) 35.0 x 10^5
   (c) 2.45 x 10^5
   (d) 3.50 x 10^5

19. Convert the decimal fraction (.7) to its lowest common fraction.
   (a) 7/10
   (b) 7/100
   (c) 7
   (d) 1/7

20. Write (236) in scientific notation.
   (a) 236
   (b) 2.36 x 10^2
   (c) 2.36 x 10^0
   (d) 23.6
Appendix VI.-Remedial Mathematics examination: Part B; design II.

INSTRUCTIONS

1. There are twenty questions to be answered.

2. After each question are four possible answers.
   You are to circle the letter preceding your selection of the correct answer.

For example:
Subtract (72.4 from 159)

(a) 87.6
(b) 8.66
(c) 86.60
(d) 186.6

(Here (c) is the correct answer.)
Appendix VI.-continued

MATHEMATICS EXAMINATION

1. Write (one hundred twenty-three and six thousandths) in decimal form using common fractions.
   (a) 123.006
   (b) 12.30
   (c) 123
   (d) .0123

2. Write (6.345) using powers of ten.
   (a) 6.345 \times 10^0
   (b) .6345 \times 10^2
   (c) 6345
   (d) .0634 \times 10^1

3. Change the common fraction \((16/25)\) to its decimal equal.
   (a) .50
   (b) .75
   (c) .84
   (d) .64

4. Find the sum \((147.49 + 7.31 + .004 + 8.4)\).
   (a) 16.3204
   (b) 1.63204
(c) 163.204
(d) 194.002

5. Subtract (3.12 from 4.7).
   (a) .158
   (b) .325
   (c) 1.58
   (d) 15.8

6. Perform the operation (51.7 - 1.11 + 4.6 - 84.1).
   (a) 28.91
   (b) 14.45
   (c) -28.91
   (d) -14.45

7. Find the product: \( \frac{14.1}{1.7} \)
   (a) 2.397
   (b) 23.97
   (c) .2397
   (d) .4724

8. Divide: \( \frac{14.346}{.74} \)
   (a) 15.4
   (b) 19.4
   (c) 18.4
   (d) 1.94
Appendix VI.-continued

9. Write \((1.36 \times 10^{-4})\) in decimal form.
   (a) 136
   (b) .136
   (c) .000136
   (d) 13.6

10. Which of the two numbers \((.000042; .00091)\) is larger?
    (a) .00091
    (b) .000042
    (c) -----
    (d) -----

11. Find the product of \((10^7)(10^6)\) using scientific notation.
    (a) \(10^1\)
    (b) \(10^{42}\)
    (c) 10
    (d) \(1 \times 10^{13}\)

12. Find the quotient of \((10^6 \div 10^{-2})\) using scientific notation.
    (a) \(10^{-12}\)
    (b) \(1 \times 10^8\)
    (c) \(10^{-4}\)
    (d) \(10^{+4}\)
13. Round the number (.05731) off to the nearest tenth.
   (a) .10
   (b) .05
   (c) 0
   (d) .057

14. Change (100%) to decimal form.
   (a) 1.0
   (b) 10
   (c) 100
   (d) .10

15. Solve: 60 is 1% of what number?
   (a) 6,000
   (b) 5,000
   (c) 60
   (d) 600

16. Solve: What percent of 12 is 6?
   (a) 100%
   (b) 150%
   (c) 50%
   (d) 25%
17. Solve: 69 is what percent of 52?
   (a) 34.5
   (b) 72
   (c) 13.26
   (d) 132.6

18. Find the quotient \((820,000 \div 0.0008)\) and express the answer in scientific notation.
   (a) \(1.02 \times 10^9\)
   (b) \(1.02 \times 10^5\)
   (c) \(.51 \times 10^4\)
   (d) \(.51 \times 10^0\)

19. Convert the decimal fraction \((.6)\) to its lowest common fraction.
   (a) \(6/10\)
   (b) \(3/10\)
   (c) \(3/5\)
   (d) \(2/3\)

20. Write \((862.4)\) in scientific notation.
   (a) \(86.24 \times 10^1\)
   (b) \(8.624 \times 10^2\)
   (c) \(.8624 \times 10^0\)
   (d) \(.08624\)
INSTRUCTIONS

1. There are fourteen questions to be answered.

2. After each question are four possible answers. You are to circle the letter preceding your selection of the correct answer.

For example:

Subtract (72.4 from 159)

(a) 876
(b) 8.66
(c) 86.60
(d) .186.6

(Here (c) is the correct answer.)
PHYSICAL SCIENCE EXAMINATION

1. Express 8,400,000 in scientific notation.
   (a) 8.4
   (b) $8.4 \times 10^6$
   (c) $84 \times 10^4$
   (d) 8400000

2. Solve: $1,000,000 \times 0.00001 \times 0.00001 \times 10000$
   (a) 10.0
   (b) 100.0
   (c) 50.0
   (d) 1.0

3. Add 100000 + 1000000 and express in scientific notation.
   (a) $11 \times 10^0$
   (b) $1.1 \times 10^6$
   (c) $111 \times 10^1$
   (d) 1

4. Solve: $\left( \frac{8 \times 10^3}{4 \times 10^5} \right)^2$
   (a) $4.0 \times 10^{-4}$
   (b) $2.0 \times 10^{-4}$
Appendix VII.-Continued

(c) \(4.0 \times 10^4\)

(d) \(2.0 \times 10^4\)

5. Solve for the unknown: \((7r-1)/9 = 1 + (3r+4)/8\)
   
   (a) \(r = 8\)
   
   (b) \(r = 3\)
   
   (c) \(r = 4\)
   
   (d) \(r = 1\)

6. Solve for the unknown: \(7x + 4 = x - 8\)
   
   (a) \(x = -4\)
   
   (b) \(x = -2\)
   
   (c) \(x = 6\)
   
   (d) \(x = 2\)

7. Solve for \(m\) in the following formula: \(F = ma\).
   
   (a) \(m = Fa\)
   
   (b) \(m = a/F\)
   
   (c) \(m = F/a\)
   
   (d) \(m = a\)

8. Solve for \(f\) in the following formula:
   
   \[
   1/p + 1/q = 1/f
   \]
   
   (a) \(f = \frac{p}{q(q + p)}\)
   
   (b) \(f = \frac{(q + p)}{pq}\)
   
   (c) \(f = \frac{(q + p)}{p}\)
   
   (d) \(f = \frac{pq}{(q + p)}\)
Appendix VII.-Continued

9. Solve the following system of equations for $x$ and $y$.

$$
\begin{align*}
2x - 3y &= 7 \\
3x + y &= 5
\end{align*}
$$

(a) $x = 2, y = 2$

(b) $x = 1, y = -2$

(c) $x = 2, y = -1$

(d) $x = 3, y = -4$

10. Solve $x^2 + x - 12 = 0$ for $x$ by factoring.

(a) $x = 2, x = 3$

(b) $x = 4, x = -3$

(c) $x = -4, x = 3$

(d) $x = -3, x = 4$

11. Solve $x^2 - 8x - 20 = 0$ for $x$ by completing the square.

(a) $x = 10, x = -2$

(b) $x = 8, x = 6$

(c) $x = 2, x = 2$

(d) $x = 4, x = 3$

12. Solve $x^2 - 5x = 6$ for $x$ by using the quadratic formula.

(a) $x = 6, x = -1$

(b) $x = 6, x = 4$

(c) $x = 4, x = -2$

(d) $x = 1, x = 3$
13. Solve \( \frac{x}{8} = \frac{9}{16} \) for \( x \).
   
   (a) \( x = 6 \)
   
   (b) \( x = 8 \)
   
   (c) \( x = 1 \)
   
   (d) \( x = 4.5 \)

14. Solve the right triangle given \( A = 30^\circ \), \( c = 20 \).
   
   (a) \( B = 30^\circ \), \( a = 5 \), \( b = 20 \)
   
   (b) \( B = 45^\circ \), \( a = 10 \), \( b = 5 \)
   
   (c) \( B = 60^\circ \), \( a = 10 \), \( b = 17.3 \)
   
   (d) \( B = 30^\circ \), \( a = 20 \), \( b = 15.2 \)
Appendix VIII.-Remedial physical science examination:
Part B; design II.

INSTRUCTIONS

1. There are fourteen questions to be answered.

2. After each question are four possible answers. You are to circle the letter preceding your selection of the correct answer.

For example:

Subtract (72.4 from 159)

(a) 876.
(b) 8.66
(c) 86.60
(d) 186.6

(Here (c) is the correct answer.)
Appendix VIII.-continued.

PHYSICAL SCIENCE EXAMINATION

1. Express 45,000 in scientific notation.
   (a) 45
   (b) 450
   (c) $4.5 \times 10^3$
   (d) $4.5 \times 10^4$

2. Solve: $214,000 \times 0.00025$
   (a) 535
   (b) 53
   (c) 5.35
   (d) .53

3. Add $42,000 - 4,200 + 42,000$ and express in scientific notation.
   (a) $4.2 \times 10^4$
   (b) 420
   (c) $4.2 \times 10^6$
   (d) $.42 \times 10^0$

4. Solve: $\sqrt{16,000,000}$
   (a) $4 \times 10^3$
   (b) $4 \times 10^2$
   (c) $4 \times 10^1$
   (d) $8 \times 10^4$
5. Solve for the unknown: \( 5 - 2x = x - 20 \)
   (a) \( x = 6 \)
   (b) \( x = 4 \)
   (c) \( x = 5.33 \)
   (d) \( x = 8.33 \)

6. Solve for the unknown: \( \frac{2}{x} + \frac{3}{x} = 10 \)
   (a) \( x = \frac{1}{2} \)
   (b) \( x = \frac{7}{5} \)
   (c) \( x = \frac{9}{2} \)
   (d) \( x = \frac{2}{3} \)

7. Solve for \( T_2 \) in the following formula:
   \[
   \frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}
   \]
   (a) \( T_2 = \frac{(P_1 V_1)}{(P_2 V_2 T_1)} \)
   (b) \( T_2 = \frac{(P_2 V_2)}{(P_1 V_1 T_1)} \)
   (c) \( T_2 = \frac{(P_2 V_2 T_1)}{(P_1 V_1)} \)
   (d) \( T_2 = \frac{(V_2 T_1)}{(P_2 V_1)} \)

8. Solve for \( n \) in the following formula:
   \[
   I = \frac{E}{(r + R/n)}
   \]
   (a) \( n = \frac{RI}{(rI-E)} \)
   (b) \( n = \frac{IR}{(rI-E)} \)
   (c) \( n = \frac{(rI-E)}{IE} \)
   (d) \( n = -\frac{RI}{(rI-E)} \)
Appendix VIII.-continued.

9. Solve in the following system of equations for $x$ and $y$.

\[ 3x - y = -6 \]
\[ 2x + 3y = 7 \]

(a) $x = -1, y = 3$
(b) $x = -2, y = 4$
(c) $x = 3, y = 1$
(d) $x = 1, y = 1$

10. Solve $x^2 = 3x - 2$ for $x$ by factoring.

(a) $x = 2, 1$
(b) $x = 1, 3$
(c) $x = 2, 2$
(d) $x = 4, 3$

11. Solve $2y^2 - y - 2 = 0$ for $y$ by completing the square.

(a) $y = 1/4, 17/4$
(b) $y = 1/2, 17/4$
(c) $y = 2, 17$
(d) $y = 2, 4/17$

12. Solve $x^2 - 6 = x$ by using the quadratic formula.

(a) $x = 1, 1$
(b) $x = 3, -2$
(c) $x = 2, -3$
(d) $x = -3, -1$
13. Solve \( \frac{21}{10} = \frac{x}{25} \) for \( x \).
   (a) \( x = 4 \)
   (b) \( x = 52.2 \)
   (c) \( x = 45 \)
   (d) \( x = 10 \)

14. Solve the right triangle given \( B = 45^\circ, a = 16 \)
   (a) \( A = 45^\circ, b = 10, c = 25 \)
   (b) \( A = 30^\circ, b = 12, c = 15 \)
   (c) \( A = 60^\circ, b = 14, c = 10 \)
   (d) \( A = 45^\circ, b = 16, c = 525 \)
Appendix IX.-Instructional-line-flow chart for control of the mathematics groups A, B and C of design III.

<table>
<thead>
<tr>
<th>Group A</th>
<th>Group B</th>
<th>Group C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(day 1) Introduction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Core lecture, pp. 73-76, Technical Mathematics, Paul Thompson and others.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cueing: five minutes; Importance of course to technologies.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(day 2) Test 1, five minutes - medium difficulty.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test 1, five minutes - medium difficulty.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Core lecture, pp. 77-80.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cueing: Director of Institute speaks to students (5 minutes).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(day 3) Test 2, medium difficulty.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test 2, very difficult.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Core lecture, pp. 81-84.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cueing: Read letter from IBM stating success of CSTI students...and how success relates to mathematics.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix IX.—continued.

Group A

(day 4) Test 3, medium difficulty.

Test 3, very easy.

Core lecture, pp. 85-88.

Cueing: Discuss the success of this class relative to others.

(day 5) Test 4, medium difficulty.

Test 4, very difficult.

Core lecture, pp. 89-92.

Cueing: Inform the class that the person having the highest averages on the daily exams will not be required to take the one-hour examination.

(day 6) Test 5, medium difficulty.

Test 5, difficult.

Core lecture, pp. 93-97.

Cueing: Post cumulative test averages on board daily.
<table>
<thead>
<tr>
<th>GROUP A</th>
<th>GROUP B</th>
<th>GROUP C</th>
</tr>
</thead>
<tbody>
<tr>
<td>(day 7)</td>
<td>Test 6, medium difficulty.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Test 6, easy.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Core lecture, pp. 98-102.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cueing: Former CSTI student visits class for last five minutes and discusses his job and its relation to mathematics.</td>
<td></td>
</tr>
<tr>
<td>(day 8)</td>
<td>Test 7, medium difficulty.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Test 7, very difficult.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Core lecture, pp. 103-108.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cueing: Present a chart showing the class average for all Ma 10 classes.</td>
<td></td>
</tr>
<tr>
<td>(day 9)</td>
<td>Test 8, medium difficulty.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Test 8, medium difficulty.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Core lecture, pp. 109-114.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cueing: Spend 5 minutes giving constructive criticism and reinforcement to class.</td>
<td></td>
</tr>
<tr>
<td>(day 10)</td>
<td>One hour departmental examination: see Appendix XI.</td>
<td></td>
</tr>
</tbody>
</table>
Appendix X.-Instructional line flow chart for control of the physical science groups A, B and C of design III.

(day 1) Introduction

Core lecture, unpublished text by Paul Tippens and Wayne Scott, pp. 1-5.

Problem assignment 1.

Selective problem assignment: easy, medium, hard (problems are placed on separate pages and students are allowed to choose easy, medium or hard problems...each counts 10 pts.

Cueing: five minutes: importance of class to technologies.

(day 2) Core lecture, pp. 6-10.

Problem assignment 2.

Selective problem assignment 2 (easy, medium, hard).

Cueing: Director of institute speaks to students.
Appendix X.-continued.

(day 3) Core lecture, pp. 11-15.

Problem assignment 3.

Selective problem assignment 3.

Cueing: letter from Combustion Engineering stating success of CSTI graduates...and how success relates to physical science.

(day 4) Core lecture, pp. 16-20.

Problem assignment 4.

Selective problem assignment 4.

Cueing: Former CSTI student speaks to class; discusses his job and how it relates to physical science.

(day 5) Core lecture, pp. 21-25.

Problem assignment 5.

Selective problem assignment 5.
Appendix X.—continued.

<table>
<thead>
<tr>
<th>Group A</th>
<th>Group B</th>
<th>Group C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Cueing:** Discuss the success of this class relative to others.

(day 6) Core lecture, pp. 26-30.

Problem assignment 6.

Selective problem assignment 6.

**Cueing:** Inform the class that the person having the highest average on the problem assignments will be excused from the first one-hour exam.

(day 7) Core lecture, pp. 31-35.

Problem assignment 7.

Selective problem assignment 7.

**Cueing:** Post accumulative problem averages on board daily.

(day 8) Core lectures, pp. 36-40.

Problem assignment 8.

Selective problem assignment 8.
### Appendix X.-continued.

<table>
<thead>
<tr>
<th>Group A</th>
<th>Group B</th>
<th>Group C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Cueing:** Present a chart showing all averages of physical science 10 classes.

**Core lecture, pp. 41-46.**

Spend last five minutes of class giving constructive criticism and reinforcement to students.

**One hour departmental examination, see Appendix XII.**
INSTRUCTIONS

1. There are twenty-five questions to be answered.

2. After each question are four possible answers.
   You are to circle the letter preceding your selection of the correct answer.

For example:

Subtract (72.4 from 159)

(a) 87.6
(b) 8.66
(c) 86.60
(d) 186.6

(Here (c) is the correct answer.)
1. Convert $\frac{5}{8}$ to its decimal equivalent:
   (a) .62
   (b) 6.20
   (c) .062
   (d) 62.

2. Convert $\frac{213}{9}$ to its decimal equivalent.
   (a) 2.366
   (b) 23.66
   (c) .2366
   (d) 236.6

3. Find the sum: $258.6 + 9.09 + .105 + 4.52$
   (a) 172.315
   (b) 272
   (c) 272.315
   (d) 2.72

4. Find the difference: $62.8 - 34.42$
   (a) 30.00
   (b) 2.788
   (c) 3.0000
   (d) 27.88
5. Find the product: \((28.6)(401.31)\)
   (a) 11,479.5
   (b) 12,479
   (c) 10,479
   (d) 13,476

6. Find the quotient: \(2,832 \div 7.14\) (to nearest hundredth)
   (a) 396.64
   (b) 42.0
   (c) 396.63
   (d) 423.7

7. Write \(0.00128\) in scientific notation.
   (a) \(0.128 \times 10^{-3}\)
   (b) \(12.8 \times 10^4\)
   (c) \(1.28 \times 10^{-3}\)
   (d) 128

8. Write \(552,000,000\) in scientific notation.
   (a) \(55.2 \times 10^6\)
   (b) \(5.52 \times 10^8\)
   (c) \(552 \times 10^{-8}\)
   (d) \(5.52 \times 10^{-8}\)
Appendix XI.—continued.

9. Write $6.28 \times 10^7$ in decimal form:
   (a) 62800.
   (b) 62,800,000
   (c) 628
   (d) .628

10. Write $3.74 \times 10^{-4}$ in decimal form.
    (a) 374
    (b) .374
    (c) .000374
    (d) 3.74

11. Find the product: $(10^5)(10^4)$
    (a) $10^{20}$
    (b) $10^9$
    (c) $10^6$
    (d) $10^4$

12. Find the product using powers of 10:
    $(25,000)(.000003)$
    (a) 7500
    (b) $7.5 \times 10^{-2}$
    (c) .75
    (d) .075
13. Find the quotient: \((10^7) \div (10^{-3})\)
   (a) \(10^4\)
   (b) \(10^{-21}\)
   (c) \(10^7\)
   (d) \(10^{10}\).

14. Find the quotient using powers of 10:
   \((4,200,000) \div (20,000)\)
   (a) \(8.4 \times 10^{10}\)
   (b) \(8.4 \times 10^{-10}\)
   (c) \(.84\)
   (d) \(84,000\).

15. Change 371.27 from a decimal to a percent.
   (a) 3.7127%
   (b) 371.27%
   (c) 37.127%
   (d) 37127%

   (a) 9.78
   (b) 9.80
   (c) 9.77
   (d) 9.0
17. Round 452,779 to the nearest ten thousandth.
   (a) 454,000
   (b) 450,000
   (c) 453,000
   (d) 460,000

18. Change .913 from a decimal to a percent.
   (a) 9.13%
   (b) .913%
   (c) 91.3%
   (d) 913%

19. Change 32.8% from a percent to a decimal.
   (a) 3.28
   (b) 328
   (c) .328
   (d) 32%

20. 32 is what percent of 92?
    (a) 34.8
    (b) 38.4
    (c) 30.0
    (d) 27

21. 417 is what percent of 516?
    (a) 80.8
    (b) 88.0
Appendix XI.-continued.

22. 44 is 78% of what number?
   (a) 46.4
   (b) 56.4
   (c) 36.4
   (d) 66.4

23. 28 is 13% of what number?
   (a) 215
   (b) 251
   (c) 280
   (d) 177

24. What is 10% of 72.8?
   (a) 7.28
   (b) .728
   (c) 728
   (d) .0728

25. What is 29% of 38?
   (a) 8
   (b) 14
   (c) 11
   (d) 20
INSTRUCTIONS

1. There are twenty questions to be answered.

2. After each question are four possible answers. You are to circle the letter preceding your selection of the correct answer.

For example:

Subtract (72.4 from 159)

(a) 87.6
(b) 8.66
(c) 86.60
(d) 186.6

(Here (c) is the correct answer.)
Appendix XII.-continued.

PHYSICAL SCIENCE EXAMINATION

1. Express in scientific notation: 45,000
   (a) 45
   (b) $4.5 \times 10^4$
   (c) $4.5 \times 10^4$
   (d) .45

2. Solve: $36 \times 10^3 \times 27 \times 10^{-5} \times 2200$
   (a) 214
   (b) 2.14
   (c) $2.14 \times 10^0$
   (d) $21.4 \times 10^3$

3. Add the following expression and show your answer in scientific notation:
   $6.8 \times 10^{-21} + 7 \times 10^{-20} - 6 \times 10^{-22}$
   (a) $7.62 \times 10^{-20}$
   (b) $7.62 \times 10^{20}$
   (c) .762
   (d) 762

4. Solve: $\left( \frac{8 \times 10^3}{4 \times 10^5} \right)^2$
   (a) $2 \times 10^6$
   (b) $2 \times 10^{-6}$
Appendix XII.-Continued

(c) 2
(d) 216

5. Solve the equation for $x$:

$5 - 2x = x - 20$

(a) $x = 25$
(b) $x = 3$
(c) $x = 75$
(d) $x = 25/3$

6. Solve the equation for $y$:

$3(y + 1) = 12 + 4(y - 1)$

(a) $y = 5$
(b) $y = 5/2$
(c) $y = 2/5$
(d) $y = -5$

7. Solve the equation for $p$:

$A = m/t (p + t)$

(a) $p = t/m(A-m)$
(b) $p = m/t(A-m)$
(c) $p = m/t(m-A)$
(d) $p = t/m(m-A)$
Appendix XII.-continued.

8. Solve the system of equations by any method:

\[ 2x - 5y = 10 \]
\[ 4x + 3y = 7 \]

(a) \( x = 65 \)
(b) \( x = 26 \)
(c) \( x = 26/65 \)
(d) \( x = 65/26 \)

9. Solve the equation by factoring:

\[ x^2 + x - 12 = 0 \]

(a) \( x = 3,-4 \)
(b) \( x = -4,3 \)
(c) \( x = 4,-3 \)
(d) \( x = 4,3 \)

10. Solve by completing the square:

\[ x^2 - 2x - 3 = 0 \]

(a) \( x = -3,-1 \)
(b) \( x = -3,1 \)
(c) \( x = 3,1 \)
(d) \( x = 3,-1 \)

11. Solve by using the quadratic formula:

\[ x^2 - 6x = x \]

(a) \( x = -3,-2 \)
(b) \( x = -3,2 \)
Appendix XII.-continued.

(c) \( x = 3.2 \)
(d) \( x = 3.2 \)

12. Solve the proportion for \( x \): \( x/8 = 9/16 \)

(a) \( x = 4.5 \)
(b) \( x = 5.5 \)
(c) \( x = 3.5 \)
(d) \( x = 0 \)

13. If \( y \) varies directly as \( x \), find \( y \) when \( x = 10 \), given that \( y = 20 \) when \( x = 8 \).

(a) \( y = 15 \)
(b) \( y = 10 \)
(c) \( y = 25 \)
(d) \( y = 35 \)

14. Solve the right triangle
where \( A = 60^\circ \), \( c = 10 \).

(a) \( B = 60^\circ \), \( b = 10 \), \( a = 5 \)
(b) \( B = 30^\circ \), \( b = 5 \), \( a = 10 \)
(c) \( B = 30^\circ \), \( b = 5 \), \( a = 8.66 \)
(d) \( B = 45^\circ \), \( b = 5 \), \( a = 8.6 \)

15. A man walks 10 miles South then 40 miles West. What is the minimum distance required for him to return to the starting point?

(a) 30
(b) 41.2
(c) 21.4
(d) 10
16. A kite string is 200 ft. long. If the wind holds the kite at an angle of 60 degrees with respect to the ground, how high will the kite be above the ground?

(a) 100 ft.
(b) 172 ft.
(c) 200 ft.
(d) 137 ft.

17. Use the slide rule to find the sine of $23^\circ$.

(a) .30
(b) .866
(c) .46
(d) .707

18. Use the slide rule to find the tangent of $30^\circ$.

(a) .45
(b) .57
(c) .36
(d) .86

19. Evaluate $768 \cdot \sin 63^\circ$.

(a) 6.83
(b) 68.3
(c) 683
(d) 6830

20. Solve for $x$: $x = \frac{314}{\sin 37^\circ}$.

(a) 400
(b) 52.3
Appendix XII.-continued.

(c) 5.23
(d) 523
Appendix XIII.-Tabulated scores received by Ss for experiment Ia (Mathematics).

<table>
<thead>
<tr>
<th>Student(i)</th>
<th>Remedial Score($X_i$)</th>
<th>Student(j)</th>
<th>Non-remedial Score($Y_j$)</th>
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Appendix XIV.-Tabulated scores received by Ss for experiment Ib (physical science).

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Appendix XV.-Tabulated scores received by Ss for experiment Ic (English).

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Appendix XVI.-Tabulated scores received by Ss for design II, remedial mathematics and remedial physical science.

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144
Appendix XVII.—Tabulated scores received by groups A, B, and C of design III; remedial mathematics.

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\[
\bar{A} = 57.21 \quad \bar{B} = 68.52 \quad \bar{C} = 71.47
\]
Appendix XVIII. - Tabulated scores received by groups A, B, and C of design III; remedial physical science.

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\[ \bar{X} = 61.60 \quad \bar{Y} = 68.18 \quad \bar{Z} = 73.60 \]
BIBLIOGRAPHY


